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Contrasts in Highway Practice

In recent issues of the *Engineering News-Record* the road-building activities of some of the Middle Western States have been reviewed. Other articles on that section of the country are to follow, but it seems desirable at this stage of the series to contrast Eastern and Middle Western practice. Accordingly, surveys of the activities of Massachusetts, Rhode Island and Connecticut appear in this issue.

In these New England States, which have had a longer experience in high-class road building, the highway thinking is concentrated on traffic and economics, rather than on types of construction and surfacing—a contrast to be expected, but none the less interesting and stimulating.

Maine's practice will be discussed in next week's issue.

Pacific Coast Impressions

Though the *Engineering News-Record* has an associate editor on the Pacific Coast, it is nevertheless the journal's practice to send editors there from the East or the Middle West to study conditions and bring to bear on the journalistic treatment of Coast problems a fresh point of view.

Just now Frank C. Wight, of the New York office, is making such an editorial trip. He has covered the chief Coast cities and areas of interest, and, in addition to technical articles, will write a series of impressions, in a more familiar vein. These will give him opportunity to appraise the spirit and accomplishments of the Coast's engineers and allow him to wander into any field of engineering interest.

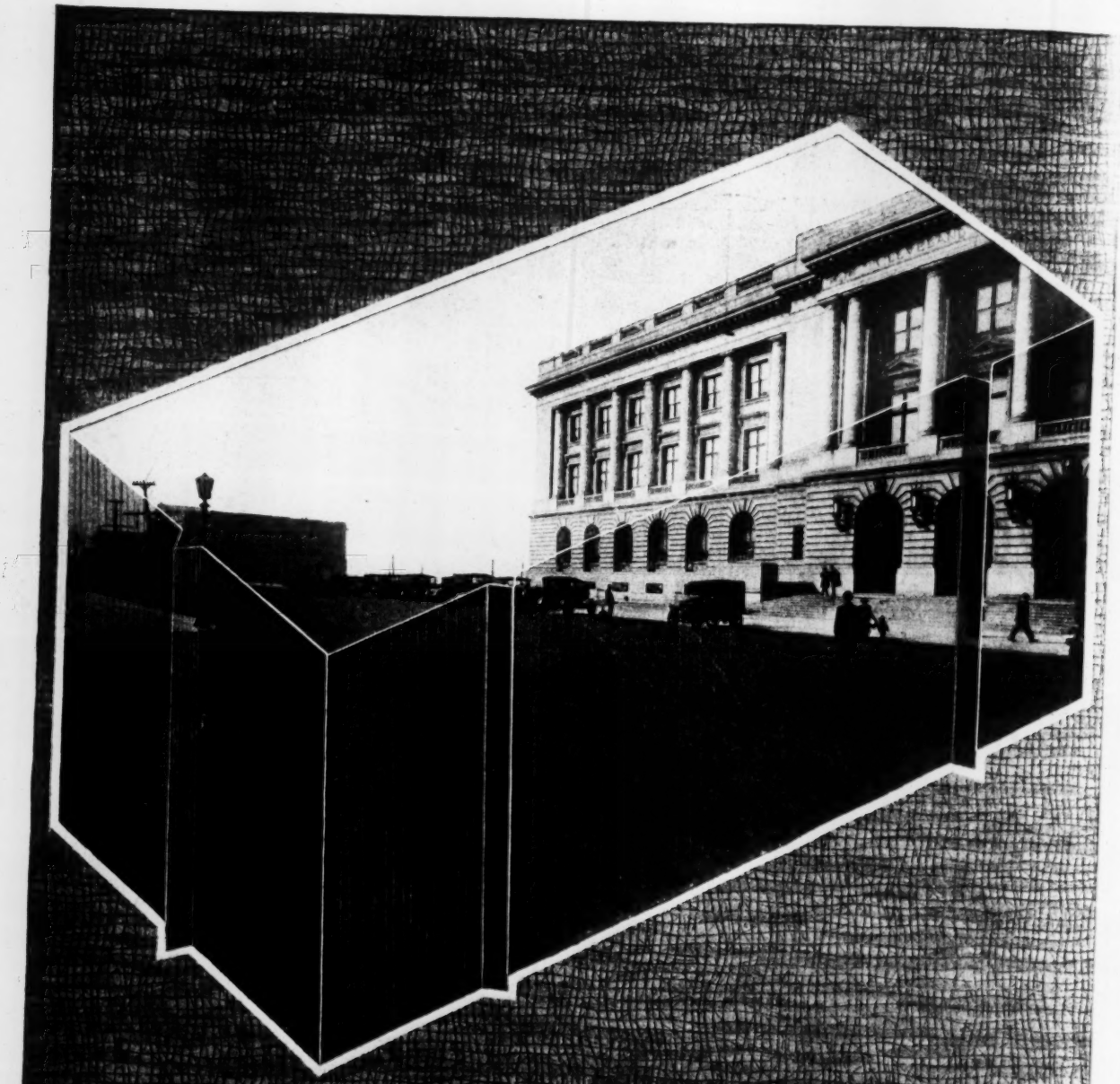
The first of these impressions appears in this issue.

Also In This Issue:

Secondary Stresses Measured in Kenova Bridge
By John I. Parcel and George A. Maney

Timbers of Tropical America and Railway Tie Supply
By Albert W. Buel

Des Plaines River Activated Sludge Plant
By Langdon Pearse



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DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

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International Road Congress

ATTENTION is called in a letter to the editor in this issue regarding the importance of having the United States represented in the International Association of Road Congresses. It should not be necessary to urge compliance with Professor Blanchard's suggestion that every engineer express to his representatives in Washington his approval of our membership in the International Association and our desire to see the next congress held in this country.

A Sound Principle

TAKING the gamble out of garbage disposal contracts was the way we characterized (Feb. 6, 1919, p. 265,) such contracts for garbage disposal by feeding to hogs as those made by Buffalo, Newark, and Baltimore in 1918 and 1919. The cities that entered into such contracts shared with the contractors the high prices for live hogs that prevailed on the Chicago market for some time, running as high as 23 cents a pound in July, 1919. And now that the price of hogs has fallen almost to pre-war level (announced as 10½ cents on Dec. 2, as compared with 8 cents in November, 1913) the prices the contractors must pay for the garbage of these cities will fall proportionately. The governing principle of these contracts might well be extended to other cities and to some other services than garbage disposal.

Highway Traffic Problem

ECONOMIC rather than structural problems trouble the highway departments of Connecticut, Rhode Island and Massachusetts. The intensity of the traffic and the presence of a comparatively small number of heavy trucks, for which expensive construction and renewals are necessary, have forced the traffic problem ahead of other highway considerations. In these three states, with an aggregate population of about 6,000,000, there are approximately 450,000 passenger automobiles and motor trucks. There is one car to each thirteen of the population and thirty cars to every square mile of territory. In addition, the highways carry a large number of foreign cars. The fact that these three states are almost entirely manufacturing communities means that they have well-developed systems of intermill and inter-city motor truck transport. Their reaction to the problem before them furnishes the theme for this week's article in the staff series upon the trend of highway development.

Safety in Rebuilding

SERIOUS accidents in the alteration of buildings are not frequent, in spite of the manifold risks inherent in such work. The collapse of a section of a nine-story building in New York City while in process of alteration is therefore a startling occurrence, but at the same time it serves as a remainder of the risks inseparable from reconstruction. Removing a carrying part of a building and replacing it by another implies a disturbance of many structural conditions, some of which it may be difficult to recognize. Minor elements of stability ordinarily neglected, but of more than negligible importance, may be involved. Skill and conscience do not always suffice to prevent accidents in such an undertaking. This is only the more reason, however, for placing fullest responsibility for safe results on competent engineering direction. Building departments, also, have a duty in the matter, while engineering societies may properly bear some of the responsibility, though their publications reveal but little discussion devoted to the subject in recent years. The Strathmore collapse may serve as a suggestion of the possibilities of fruitful work in this field.

Curves and Setbacks

IN THE residence district of cities a pleasing diversity of scene may often be introduced by the use of curved streets and by varying the setback distance of the fronts of houses or of groups of houses. This is well known to those who have given much attention to city and town planning, but would seem like a bad practice to many real estate developers, to layman city officials, and we fear also to many city engineers. Curving streets and unequal building setbacks might also be introduced at times and places in other than residence sections. In all cases such variation from the straight line for streets and the uniform setback line for the whole length of a street must be planned with careful regard to both appearance and convenience. Where municipal engineers and representatives of real estate owners lack the necessary training and taste for this sort of planning, as is often the case, the services of a landscape architect and city planner will be needed. Some of the books on city planning contain useful hints on the subject.

The Science Bond

THOSE who have had occasion to meet or correspond with engineers and scientists of the former "Central Empires" know that they have a conviction that it is through the contact of scientific men that an understanding between the former belligerent nations can most quickly be brought about. It is held that science is dispassionate and that admiration for each other's solid scientific achievements is a good basis for the establishment of relations. Judging by a recent occurrence in England, the desire for reconciliation extends to leaders in the arts and literature as well. In October a letter was addressed to the universities of Central Europe by many "doctors, professors, and other officers and teachers" of Oxford, inviting the restoration of amicable relations. The signers were men of

many pursuits. As was to be expected, there was controversy as to the advisability of such an approach, but the subsequent letter signed by sixty-five more teachers, most of them tutors, showed that the younger element —including many who had seen war service—agreed with the maturer men who had written the first letter. Great Britain, as in all things international, has again taken the leadership. Evidence is not lacking that in this country, within the last year, has come a similar feeling that international intellectual relationships should again include the central powers. Certainly we should not shut ourselves off from whatever of technical advance may be made by our former enemies.

The Personal Questionnaire

AS A MEANS of securing numerous opinions and data on a particular subject the questionnaire system is well established, but a newer and less frequent application is its use by an individual as a means of determining his own knowledge or lack of knowledge of a given subject. Two such applications of the personal questionnaire are suggested in *Engineering News-Record* of Oct. 14 and 28, pp. 727 and 823, for use by municipal and railway engineers respectively in considering the problems of snow removal and of electrification. For this purpose the engineer sets down more or less at random, questions and factors relative to the matter in hand, and then proceeds to fill in the data. That is, he first visualizes the various aspects of his problem and then arranges them in logical sequence; after which the can readily determine what information he possesses and what he needs to solve his problem. The personal questionnaire concentrates and clarifies opinion and knowledge, besides showing clearly where links are missing.

Fourteen Backward States

THIRTY-THREE states and the District of Columbia gather and record mortality statistics with sufficient accuracy and completeness to be included in the Census Bureau's registration area. Fourteen are so backward and so regardless of one of the very fundamental of public health protection as to be classed in the non-registration area. For the year 1919 the registration area showed the record-breaking low death rate of 12.9 per 1,000. What the death rate was in the fourteen backward non-registration states no one knows. The presumption is that in most of them it was relatively high, since states that neglect to record the birth and death of their citizens are likely to do less than they should to conserve their health in the intervening period. Since all the legislatures meet in 1921, an opportunity will be afforded to bring every state into the registration area and to pass needed sanitary legislation as well. The fourteen states in the non-registration area (shown in black, *Engineering News-Record*, April 8, 1920, p. 732) are as follows: Alabama, Arizona, Arkansas, Georgia, Idaho, Iowa, Nevada, New Mexico, North Dakota, South Dakota, West Virginia and Wyoming. Engineers in these states have a duty to perform. They should stir the people to insist that their legislators and administrative officers take immediate measures to place their states in the registration area. Some of the fourteen states outside that area are doing good work through their health departments, but lacking complete and reliable vital statistics those departments cannot work with full intelligence and efficiency.

Federal Intrastate Rate Control

WITH the Interstate Commerce Commission's order to railroad companies in three states to initiate and file rates within those states conforming to interstate rates already ordered, there is now the possibility of a Supreme Court decision greatly widening Federal powers of intrastate regulation of public utilities services which affect interstate commerce. The order of the commission appears generally to have been expected as conforming with the mandate of Congress in the Transportation Act directing the commission finally to adjudge and act in disputes with state bodies in equalizing intrastate with interstate rates. The opinion is widely held that the act is clear in this respect, and it would be difficult to sustain the charge that the commission has done otherwise than merely carry out the law. The State of New York has already announced its intention to take the case to the Supreme Court, and in its case the inviolability of a contract in the charters granted the railroad company is involved. Wisconsin and Illinois, it is understood, also propose to contest the commission's order.

In the New York case the contest is over passenger rather than freight rates, since the original state charters, and later state statutes, fixed only passenger fares, but the principle involved is so broad that the effect may be felt not only in intrastate passenger fare regulation but also in other public utilities services within states which affect interstate trade. "The Congress shall have Power . . . to regulate commerce with foreign Nations, and among the several states, and with Indian Tribes." This basic clause from the Constitution of the United States is the foundation and cornerstone upon which have been based all of the present sweeping powers of Federal regulation, and it is significant that the tendency of Supreme Court decisions has been to broaden rather than to restrict the powers of Congress in this respect.

One of the principal points at issue is the inviolability of state charters from the contract viewpoint. But from the viewpoint of expediency and the public good in regulating, rather than restricting, interstate commerce, we believe the principle sound that state commissions should not be permitted to exercise powers that tend to restrict commerce between the states. If intrastate rates are forced down, interstate rates will have to go up to bring the stipulated net return on aggregate value, which would act directly as discrimination against traffic across state lines. Thirty-one states have already acted to conform with rates prescribed by the Interstate Commerce Commission and eight states have opposed it—some on grounds of state charters and some on grounds of state statutes.

It needs to be recognized that charter provisions are arrived at as the result of bargaining between the state and the company involved. In return for certain privileges the company contracts to give certain service or to perform service at a stated rate. If the rate or the service be changed by Federal order, the whole contract should, in equity, be reconsidered.

Naturally some state commissioners are much exercised over the threat to their powers that is carried in the Transportation Act. This was strikingly brought out at the recent meeting at Washington of the National Association of Railway and Utility Commissioners, reported in *Engineering News-Record* of Nov. 18, 1920

p. 1013. But, as we view the case, it is a question of national policy and national good as opposed to local policy and local benefits. True, the matter of abridging state charters, considered as contracts, is a serious step. Here, some of the states that still hold out against conformity with Interstate Commerce Commission rates have their strongest talking point. However, in 1912 the Supreme Court rendered a decision that state commissions "should" conform intrastate rates to those prescribed by the Interstate Commerce Commission, but denied the power of the commission to order such conformity. Here, the court made clear that, equitably, intrastate should conform to interstate rates, but that the commission could not enforce such rates legally, having no authority from Congress to do so. Now, by the Transportation Act, Congress has given this authority to the Interstate Commerce Commission and, if we may draw conclusions from the Supreme Court record of interpreting the Constitution with respect to Congressional powers over interstate commerce, the law is likely to be sustained.

Early Contract Letting Again

EMPHASIS has already been placed in these columns on the need for early letting of contracts for next season's work. The matter is of such grave importance, however, that frequent repetition is fully warranted. The argument applies to all classes of construction. It is to be understood, however, that it is not urged that all contemplated work should go ahead. There are good reasons for postponing unnecessary construction. But if work *is* to be done next season it should be let as early as possible.

Early letting has decided advantages. The early contractor gets the pick of labor forces; he can get his plant on the ground before the spring rush begins; he can get sidings laid, and, on highway work for example, can get his quarries opened and his plant under way for gravel-bank development. Where conditions are favorable he may even be able to stock-pile materials. So much for the contractor himself.

But the advantages extend farther back. With the business slackness that is upon us manufacturers of construction equipment and materials cannot be expected to manufacture for stock on a large scale unless figures are available as to the volume of the season's work. In the case of equipment manufacturers their raw stock inventories are already a serious burden. Good business judgment forbids increasing the inventories by turning the raw stock into finished product beyond a clearly evident demand. A general late letting of contracts, therefore, will find the equipment companies unable to meet the demands of their customers for spring shipment.

As against the advantages of early-spring letting we have heard of only one disadvantage—the likelihood that prices will drop in the spring and thus allow lower bids to be secured. It is probable, though, that the greater part of the drop will come within thirty days.

Offsetting, moreover, any financial gain that might accrue from late letting is the indisputable fact that late letting seriously endangers the completion of the work—which always results in heavy loss to both sides.

We are still in the early part of December, and, if measures be taken in hand now to let contracts early, can get next year's work started in the early spring.

Increasing the Efficiency of Bridges

EXPERIMENTAL verification of the theory of load-distortion stresses in steel structures is materially strengthened by the measurements on the Kenova bridge recorded in this issue. The numerical results prove that this secondary stressing occurs in precisely the way indicated by calculation. Those who still adhere to the view that such actions may safely be ignored in practical designing will find little comfort in the tests, for they plainly show that the bending stresses caused by truss distortion diminish the available strength of the steel by a significant fraction.

Because of the complicated, tedious character of the calculations required for determining secondary stresses, thought on the subject has not become entirely clarified, in spite of the fact that for thirty or forty years past these stresses have been known to exist and have been discussed more or less frequently. There is a general substratum of belief that a flat percentage allowance will take care of them, or in other words that it will do to let them go into the safety margin. The new figures supplied by Professors Parcel and Maney, however, indicate that this convenient method of dealing with the matter is not safe unless the allowance is made wastefully large.

The new specifications of the American Railway Engineering Association prescribe complete calculation of secondary stresses, in place of ignoring them or attempting to cover them by a flat allowance, but only when the members of the structure are unusually stiff or when sub-paneled construction is used. The practical obstacle in the way of applying this rule is that the time required for the calculation will limit its application to quite exceptional instances. As the importance of the actions in question depends essentially on the form or type of the structure rather than on its dimensions, considerable assistance might be given the working bridge engineer if a compilation of bridge forms and their respective calculated amounts of secondary stress were made available to him. The figures given by such stress sheets would naturally involve a certain small range of error when applied to any actual bridge of the same type, but they would be so much more correct than anything now obtainable (except by very tedious calculation) that they would undoubtedly increase the safety and efficiency of bridge construction.

In the future development of the art, as the distortion stresses in bridges come to be more familiar and their amounts more precisely known, it may be timely to consider what, if anything, can be done to reduce or eliminate the extra tax on the material which they represent. With respect to those stresses which arise during erection of a structure, being caused by its initial deflection under its own weight, expedients to eliminate some large local distortion effects have already been worked out and are more or less commonly applied in large structures; this is true particularly of the excessive constraints at the first lower-chord panel point and at the junction of end post and collision strut. In the matter of moving-load secondary stresses nothing of the kind has been attempted, and it is difficult to predict how much can be accomplished. But even if they amount to no more than five or ten per cent of the total tax on the material in a bridge, their elimination would mean a worth-while gain in carrying capacity, or in economy Study of the subject will not be waste of time.

Secondary Stresses in Kenova Bridge Measured

Tests to Determine Secondaries at Four Joints Under Moving Coal Trains Give Satisfactory Check With Calculated Results—Effect of Load Variation and Floor Stiffness

BY JOHN I. PARCEL AND GEORGE A. MANEY
Professor of Structural Engineering Asst. Professor of Structural Engineering
University of Minnesota

IN SEPTEMBER, 1917, the writers made a series of measurements of secondary stresses on the 520-ft. span of the Norfolk & Western Ry. bridge over the Ohio River at Kenova, W. Va. (see Fig. 1.). The stresses were measured for regular train loading and the object of the investigation was to arrive at a comparison of computed and measured secondary stresses for these conditions.

Many other attempts* to determine secondary stresses experimentally have been made, but so far as is known

FIG. 1. KENOVA BRIDGE; STRESS MEASUREMENTS MADE ON MAIN SPAN

no test has been made on a structure of anything like the size of the Kenova bridge except that on the Hell Gate Arch, and in this case the measurements were for *dead-load* secondaries only.

Instruments and Methods.—The strain-gage used is shown in Figs. 2, and a typical attachment in Fig. 3. The multiplying device was so adjusted that one division on the dial corresponded to an elongation of 0.0001 in., which on a 50-in. gage length is equivalent to a stress of 60 lb. per sq.in., taking 30,000,000 lb. per sq.in. as modulus of elasticity of the bridge steel. A gage length of 50 in. was selected with a view to the elimination of purely local effects.

All members on which measurements were taken were of two-rib construction. In most cases a pair of instruments was placed on each rib, though for some cases, as later noted, the readings were confined to one rib.

The instruments on each rib were lined up vertically and each was at or near the plane of the extreme fiber. For symmetrical sections obviously the half sum of the readings (reduced to stress terms) of either pair of instruments should give the primary stress and the half difference the secondary stress in the plane of the instrument. With this arrangement of instruments and simultaneous readings, it is believed that temperature errors were largely eliminated.

Scope.—It has been said that the purpose of the investigation was to secure a comparison of computed and measured secondary stresses. There was no special reason, therefore, for examining a large number of joints. Two typical top-chord joints, *F* and *G*, and two bottom chord joints, *b* and *d*, were selected for investigation. At *b* and *d* the secondary stress is maximum at full load, at *F* and *G* for partial loading. The choice of joints was made as being representative of these two classes rather than because of especially large stresses developed. As a matter of fact the secondary stress at *F* and *G* for full loading is quite small.

Test Procedure.—For practically all the tests a heavy freight (usually coal) train of some 60 to 80 cars, drawn by a Mallet compound locomotive formed the loading. The trains all passed northward across the bridge, and due to the heavy grade of the south approach and local traffic conditions they rarely attained a speed of more than 15 miles per hour; usually they ran much slower. This fact eliminated all impact complications. In all cases the vibration of the needle of the Ames dial was so slight as to have no material effect on the accuracy of the readings.

In taking readings an observer was assigned to each instrument and an additional observer noted the approximate location of the train and also, usually, gave the signal on which the instruments were read. This method of timing readings proved quite satisfactory because of the very gradual variation of stress. Slight

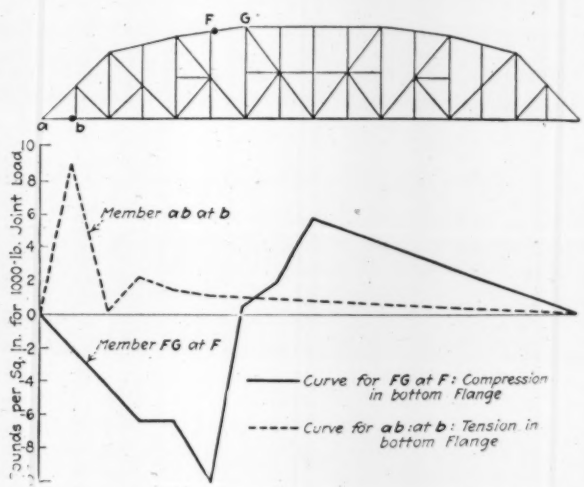

FIG. 1A. VARIATION OF SECONDARY STRESS SHOWN BY TWO INFLUENCE LINES FOR KENOVA MAIN SPAN

deviations from exactly simultaneous reading of the instruments could have but negligible effect on the results. No effort was made to space the readings at equal intervals. During the periods when the train was entering and leaving the span and the load was rapidly changing, readings were taken much more frequently than when the bridge was under a substantially uniform load. During the former period the interval was roughly from 3 to 6 seconds, during the latter from 20 to 30 seconds.

Data and Results—After all doubtful sets of readings had been discarded there remained 18 sets possessing all the marks of trustworthiness. Eight of these were taken at joint *b*, two at *d*, six at *F* and two at *G*.

In the reduction of the field data it was necessary

*See, among others, W. Fraenkel, *Der Civilingenieur*, 1883; M. Rabut, *Annales des Ponts et Chaussées*, 1901, III; W. Gehler, "Nebenspannungen eiserner Fachwerkbrücken," Berlin, 1910; *Bulletin A. R. E. A.*, Nos. 125 and 163; D. B. Steinman, *Trans. A. S. C. E.*, Vol. LXXXII.

for comparison with computed values, to make some corrections for the location of the instruments. In general the strain gage could never be attached so that the plunger bar was in the exact plane of the extreme fiber, nor could it be attached at the very extremity of the members. In order to arrive at the maximum secondary stress (for only this could fairly be compared with the results of conventional computation) the method of linear interpolation was adopted. The adjustment to the extreme fiber requires no comment. The correction for longitudinal location of instrument was arrived at as follows: The inflection point for the member was located approximately. For all cases considered this could be taken as $\frac{1}{8}l$ from the joint in question. Then to transfer the stress reading at a given section to the stress at extremity of member it was only necessary to multiply the reading by the ratio of the distance between inflection point and panel point to the distance between inflection point and center of gage length.

The corrected strain-gage readings, reduced to stress terms, were plotted up into the curves labeled "Measured Primary" and "Measured Secondary" in the accompanying Figs. 4 to 10. These graphs are believed to represent the history of the actual primary and secondary stress as a train passed over the bridge. For

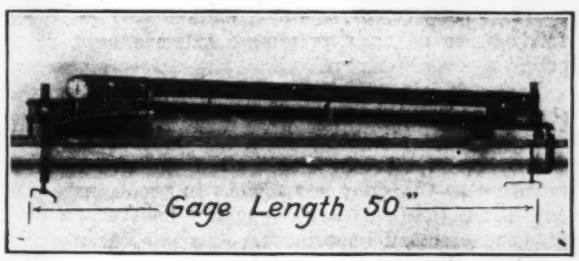

FIG. 2. STRAIN GAGE USED IN KENOVA WORK

all measurements except those at F the plotted values are the average for the two ribs. Readings at F were taken on one rib only.

Exact determination of the train loading was impossible, but a very fair check on the average intensity could be obtained from the measured primary stresses. It was assumed that a load of 4,000 lb. per foot of track and an excess load of 2,000 lb. per ft. for the first 70 feet would approximate the form of the actual loading and would represent the maximum limit of the actual train loads. This loading was called arbitrarily Class 40. A curve of primary stress corresponding to the passage of this loading was constructed, and this was compared with the measured primary stress curve in each case and adjusted to agree with the average ordinate of the latter. If this adjustment required a 25 per cent reduction in a given case, it was assumed that the actual train loading for that case approximated Class 30, this being three-fourths of Class 40 loading.

Prior to the test a complete analysis for the secondary

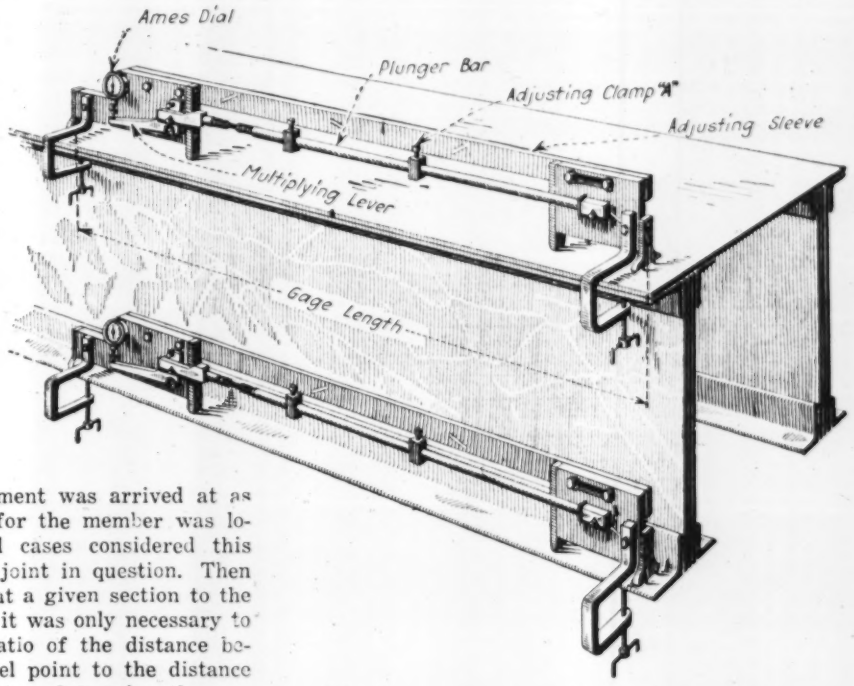

FIG. 3. POSITION OF STRAIN GAGES ON TOP CHORD

stresses in the Kenova truss had been made for unit joint loads, and secondary stress influence lines had been constructed. From these the "computed secondary stress" curves were obtained by using the train loadings derived as above.

A comparison of computed and measured secondary stresses on this basis of a conventionalized loading tacitly assumes that a given loading produces the same relative effect on both primary and secondary stress. This is never strictly true and in some cases far from the truth. It would be easy to devise two loadings of the same *average* intensity and producing approximately the same primary stress which would give secondary stresses varying by perhaps as much as 40 or 50 per cent, though such extreme variations are, of course, improbable. Therefore we are not strictly justified in assuming that, because the irregular loading of the actual train which traversed the bridge during a given test is fairly represented by a conventional "class 30" so far as *primary* stress is concerned, "class 30" will also produce the same secondary stresses as the actual train. In spite of these limitations in an individual test, however, the method should give a very useful comparison when applied to a large number of tests.

In Figs. 4 to 10 are plotted nine typical sets of readings. It is believed that these graphs are largely self explanatory. One or two points may be noted. A closer study of the local deformations in the panels investigated brought out the fact that for all subpanel points (b, d, F) a large relieving effect due to the stiffness of the floor system, induced stresses in auxiliary members and the like, might be anticipated. Such effects, of course, were not included in the calculation of the secondary stresses. Following certain assumptions as to the continuity and end condition of the members involved, a theoretical analysis of these relieving influences was made. This indicated, for lower-chord joints, a reduction of approximately 35 per

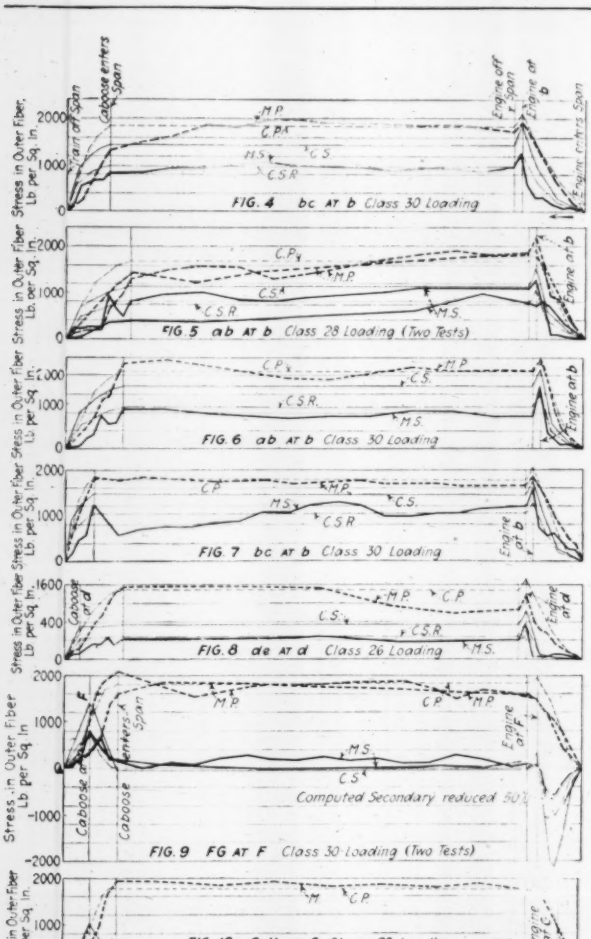
FIG. 4 bc AT b Class 30 Loading
FIG. 5 ab AT b Class 28 Loading (Two Tests)
FIG. 6 ab AT b Class 30 Loading
FIG. 7 bc AT b Class 30 Loading
FIG. 8 de AT d Class 26 Loading
FIG. 9 FG AT F Class 30 Loading (Two Tests)
FIG. 10 G H AT G Class 28 Loading
Computed Secondary reduced 50%
Primary Stress
Secondary Stress
Measured
Computed
Computed reduced 35% for relieving effects

FIGS. 4 TO 10. MEASURED AND CALCULATED SECONDARY STRESSES IN KENOVA BRIDGE—TYPICAL CURVES

(Horizontal scale of stress curves approximate only. Loading for calculation of secondaries determined by adjusting curve of measured primaries to calculated primaries.)

cent from the conventionally computed values, and for upper-chord joints such as *F* approximately 50 per cent. Graphs of the computed secondary stresses so reduced are shown by light dash-and-dot lines in the figures for all sets of readings on joints *b*, *d* and *F*.

In studying the correspondence between the computed and measured secondary-stress curves it should be kept in mind that the only fair comparison is between the percentages, secondary to primary, of measured and computed values. The actual train loadings were never exactly uniform, consequently the computed primary curve could never be adjusted to more than approximate agreement with the measured curve. At some points the discrepancy was very considerable, and, though the effect of load variation on the secondary stress is not necessarily the same as on the primary —a point discussed in an earlier paragraph—we could hardly expect the former to show any better correspondence with computed values than the latter. In Fig. 8, for example, engine at "*d*", the measured secondary curve falls much below the computed values, yet the percentage of measured secondary to primary is almost the same as the percentage of calculated secondary to primary.

Summary and Conclusions—The results of the investigation may be briefly summarized as follows:

1. The eighteen sets of readings, taken as a whole, exhibit a remarkable degree of conformity to calculated values.

2. Where important discrepancies appear, they would seem to be fully explained by a more thoroughgoing analysis of all the factors contributing to the panel deformations.

From these results it would seem fair to conclude (in so far as it is justifiable to draw general conclusions from a single test) that *the actual live-load secondary stresses in a bridge of the Kenova type can be accurately calculated from the elastic theory*, though it may be necessary to include in the calculations certain factors ordinarily neglected in the conventional method of computation. This is the most important conclusion to be drawn from the test.

Attention may be called to one or two other points.

In harmony with what has already been said on comparative stress actions of two different loadings, it is to be noted that sharp variations in intensity of loading over short distances will have a very much greater effect on secondary than on primary stresses. If the secondaries are computed for an equivalent uniform load suitable for the calculation of the primary stresses, the normal variations in actual service loading may be expected to result in very considerable fluctuations in the percentage of secondary stress, above and below the normal computed average. For all joints studied except *F* it seems probable that this variation may largely offset the relieving effects, so that the *conventionally computed value, without correction*, may fairly serve as an approximate extreme limit of the actual secondary stress.

For such joints as *F* the relieving effect is so great that the ordinary calculation, if made for maximum conditions, gives altogether excessive results. The test would appear to show clearly that the effect of such members as *fF* is far less serious in producing secondary stress than has been generally believed—a result of some practical importance.

The conventionally computed secondary stresses in trusses of the Kenova type will vary from practically zero in some members to 80 per cent of the maximum primary in others—even more in some extreme instances. The measured secondary stress at the joints examined in the present tests shows a corresponding variation. For member *ab*, at *b*, in one case the measured secondary was approximately 85 per cent of the measured primary, and this, too, when the primary was a maximum. Fig. 8, for end *F* of number *FG*, shows that the secondary co-existing with maximum primary is between 5 and 10 per cent of the latter. This emphasizes the point that any blanket percentage allowance applied alike to every member (a method commonly used in most offices) is an unscientific and inadequate method of providing for secondary stresses.

The writers feel that the results of the test are distinctly encouraging and are such as to justify further investigations, which if carried out comprehensively should give the profession valuable and much needed information regarding bridge action under service conditions.

The writers beg to acknowledge their indebtedness to the officials of the American Bridge Co. for data on the Kenova bridge and many valuable suggestions; to J. E. Crawford, chief engineer of the Norfolk & Western R.R., whose generous co-operation made the test possible, and to Franklin R. McMillan, now assistant engineer for the Turner Construction Co., at that time assistant professor of structural engineering at the University of Minnesota. Mr. McMillan was wholly responsible for the design of the strain gage used, and he also furnished invaluable aid in carrying out the test.

It is planned to publish soon a more detailed account of the investigation as a bulletin of the Engineering College of the University of Minnesota.

What Should Be the Dimensions of A Shipping Pier

An Engineering Inquiry Into the Size of Piers and Ships for Various Classes of Ports and Service

By H. McL. Harding
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CURRENT controversies as to the dimensions proper for shipping piers are based largely on past practice or expected service. Little has been done to analyze the necessities of the case and to determine from an engineering standpoint the proper dimensions to be used. An attempt at such an engineering inquiry is made herewith.

It may be accepted that where possible the linear water frontage contiguous to a city, proportional to the size of the city, is limited, and must be conserved by designing for as many ship berths as possible, but without permitting unnecessary freight congestion on the piers or in the slips. To the deductions and conclusions as to the width of piers and slips for the transferring and handling miscellaneous cargoes there are many exceptions, but the general principles may be regarded as approximately correct for what are called public piers, for all kinds of freight, and not the continual use for special cargoes.

There is a ratio between the length of the pier and the width of the pier and the width of slip—if on the unit basis of length—the unit length being equal to the longest ship which it is judged will there be berthed for a number of future years, any extra length providing for the future to be utilized at present for holding harbor craft. A two-ship berthing length on each side of a pier would require a wider pier and a wider slip than if for the one ship's length. It will therefore be seen that the width of the pier and slip is a resultant of temporary holding capacity and longitudinal and transverse conveying space of the pier and similarly the width of the slip depends upon the berthing of ships and barges and the movement of ships and barges in and out the slips.

In general, as above for a one-unit length of pier of an ocean port, the width of the slip should accommodate, parallel to each other, a coal barge, a ship, another barge, another ship and a coal barge with ample clearances. For a two-unit length of pier there should be barge, ship, barge, space for an inner ship to pass in and out, barge, ship and barge, also with ample clearances all parallel to each other.

Piers may be divided into four classes, namely, inland river barge piers, 12 ft. draft (of those there will be very few), inland river ship piers, Great Lakes Piers and ocean port piers. The possible dimensions for piers in each of these classes for one-ship and for two-ship unit lengths are given in the accompanying table. The reasons for the selection of these dimensions are given below with the idea of stimulating discussion which may lead to the establishment of commercially practicable terminal rules or principles.

DIMENSIONS IN FEET OF SHIPPING PIERS FOR ONE-SHIP AND TWO-SHIP LENGTHS

Type	—One Ship Length— Length	Width	Slip	—Two Ship Length— Length	Width	Slip
Inland River Barge	300–350	130	150	600–700	150	180
Inland River Ship	500–550	140	280	1000–1100	150–160	340–350
Great Lakes	700	140–160	280–300	1400	200	340
Ocean	600–700	150–160	300	1200–1400	220	350

Inland River Barge Piers.—One unit slip width between two piers should provide for four barges, 35 ft. each, parallel to each other with clearances, or three barges of 45 ft. each. There should be pier capacity for four railway tracks, and one shed 200 x 60 x 30 ft., and 100 ft. open area.

On inland rivers and canals with not more than twelve feet depth 350 ft. may be taken as a unit length, possibly 300 ft.

It is expected that there will be constructed many inland river barge piers but rather quays, except at the confluence of two rivers where there may be bays scoured out and where diagonal piers might be possible. If by any possibility there are such piers, they would probably be one unit in length. They might be useful for a small tonnage capacity. To transfer any volume of freight quickly would require five units of 300 ft. each, and this would be only 3,000 ft., a little more than one-half mile.

Any conception of an inland river barge terminal should take into consideration not less than several hundred thousand tons to make a modern terminal a commercial success. It will therefore be seen that the widths of slips as given may be considered the minimum allowable, which would be small indeed for a large tonnage. In any such inland river terminal, all insistance should be made to provide for a large tonnage and to be able to add many units from time to time. There must be an interchangeability between barges and from one pier to another, and provision must be made for a comprehensive plan embracing many lengths of 300 ft. with the nearby warehouses supporting the sheds. In certain cases there may be ten units and all should be physically connected by car tracks and dray approaches. Too often a large tonnage requiring great cubical content has not been embraced in a comprehensive plan for the future.

A successful terminal is one which has facilities and can transfer a large tonnage in a short time easily and without congestion. The piers should be of sufficient width to provide for four tracks in addition to the shed.

Inland River Ship Piers.—Even here quays are preferable, and as the same principles apply as with the Great Lakes piers and ocean-port piers, reference will be made to these for suggestions.

Great Lakes Piers.—There are ships on the Great Lakes 625 ft. in length, and as the depth of the channel is fixed at 21 ft., there will probably be an increase in length, and also in breadth which is now over 60 ft. The unit length is therefore taken at 700 ft.

Ocean Ports.—At ocean ports, from a study of the

dimensions of freighters, not passenger ships, the unit length has been taken at from 600 to 700 ft.

For such piers of one-unit length there would be two sheds each 200 ft. long, in tandem with 100 ft. between them. A pier of two unit-lengths from 1,200 to 1,400 ft. would have four sheds. The width of the pier is closely connected with the shed capacity. One shed 200 ft. long, 80 ft. wide and 25 ft. tiering height would have a cubic foot capacity of 200 x 80 x 25 ft., or 400,000 cu.ft., and the two sheds 800,000 cu.ft., or the equivalent of two ships each of 4,000 tons. If of 200 x 1,008 x 25 ft. size, the cubical capacity for two sheds would be 1,000,000 cu.ft., or of two ships one on each side of the pier, each of 5,000 tons. This capacity at 100 cu.ft. per register ton includes the working area and is based upon careful estimates. On a 600 ft. pier, 400 ft. of the length is taken by the sheds, and there are 200 ft. additional for coarse freight.

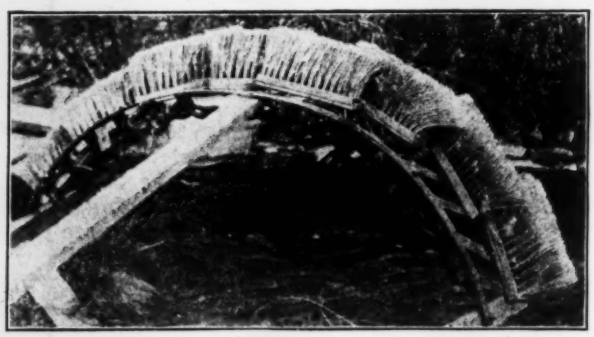
Of the 1,000,000 cu.ft. of cargo a portion will pass over the side of the vessel upon barges, some may be loaded directly on cars or taken away immediately by drays, other portions will be taken away from the shed as soon as it is assorted and distributed.

Of the width of 150 ft., 70 ft. is for railway tracks and dray ways. The 200 ft. in length not covered by sheds would be an area 200 x 80 ft. = 16,000 sq.ft., or 20,000 sq.ft. Tiering 25 ft. in height would give 400,000 to 500,000 cu.ft. additional capacity for coarse freight. With a 700 ft. pier, there would be an outside capacity of 600,000 cu.ft. for open freight.

If there are four ships berthing at a two-unit ocean-port pier, two on each side, there must not only be a holding capacity in the sheds opposite the two outer ships, but there must be space for the longitudinal freight movements from the outer half of the shed to the rear shore. There should be two railway tracks on each side of a pier, three tracks would be better.

Scrubbers for Semi-Circular Flumes

FOR clearing semi-circular flumes of moss and silt in the Yakima Valley, Washington, heavy bristle scrub brushes are secured to a semi-circle of wood which is supported at the base end of a triangular frame. As described in the *Highway Magazine*, a wheel on the apex end of the frame, which is directed downstream, guides and keeps the device from wedging. The illustration shows the scrubber upside down. A heavy chain to add weight and hold the brushes against the sides of the flume may be noted under the brush support. The scrubber was devised by Charles B. Schmidt, manager of the Selah-Moxes Irrigation District.



Trend of Highway Development —a Survey

Practice in Connecticut, Rhode Island and Massachusetts

THIS IS THE FIFTH of a series of articles on the highway situation. It discusses the trend of Connecticut, Rhode Island and Massachusetts toward first consideration of economic, rather than structural problems. The pioneers in roadbuilding work, they are confronted with traffic problems that far outweigh other highway considerations. Connecticut and Massachusetts present particularly serious situations.

Other points of interest in the practice of these three states are: The "floating gang" maintenance of Connecticut; the success of penetration macadam roads in Rhode Island; and the authority given district engineers in Massachusetts in designing all but surface types.

The sixth article in the series will appear in next week's issue.—EDITOR.

Connecticut Practice

CONNECTICUT'S highway attention is focussed upon traffic. Insofar as is possible construction types are determined. Materials, transportation, labor—problems concerning these are only relatively troubling. The real disturbing factor is traffic: How far heavy units are to govern design; and how commercial vehicles are to be made to pay a proper share of highway construction and maintenance costs. As yet these questions have not advanced to the stage where solutions are possible. With a consideration of traffic problems should go some discussion of the organization set up to keep the roads in repair.

A large percentage of the traffic that passes over Connecticut's roads originates or terminates at points outside the state. Three of the main trunk-lines are in the routes from New York to Boston, New York to Providence and New York to Springfield, respectively. Traffic counts on the New York-Providence route show that, of 173,000 cars crossing the Saybrook-Lime toll-bridge in a year, 46,000 carry foreign licenses. It is estimated that at least the same proportion of total traffic using the New York-Boston road is foreign. The state, therefore, pays for construction and renewals for a heavy traffic, 25 per cent of which gives to the state not a cent of revenue.

TRAFFIC PROBLEM

Of 20,000 motor trucks registered in Connecticut about 16,000 are under two-tons capacity, and only 650 are over four-tons capacity. There are registered approximately 90,000 passenger cars rated at not over two tons. To provide a highway adequate for the needs of the 650 heavy trucks costs, it is estimated, twice the amount necessary for the 90,000 passenger cars and the 16,000 light trucks. Involved in the question as to the necessity or advisability of providing, by heavier construction, for such a very small proportion of the total traffic is the fact that money which otherwise would be utilized in extending the highway system, is used in expensive renewals and maintenance.

The highway commissioner of Connecticut believes that a highway department must do at least two things to be rated as progressive: Provide for existing traffic through renewals, repairs and maintenance; and, by

extension of the state system, provide for the normal increase in traffic resulting from quickened commercial activities as well as traffic resulting from haulage of materials over highways at no matter what cost, due to a temporary breakdown in other means of transportation. Construction types will be of secondary importance, then, at least until some approximation has been made of the probable weight and intensity of traffic.

Because of the amount of money that has had to be expended on heavier construction to accommodate the small percentage of heavy traffic, the money for the extension of the state system has not been adequate. The question then has arisen in Connecticut as to the advisability of making the heavy trucks pay for the improvement that they alone necessitate. How can these heavy units be made to pay? The commissioner's first answer, which is an admittedly impossible one, is to charge toll. The next one which he offers as a possible solution is to make every truck using the roads carry a Connecticut license. The added revenue would pay for the damage that the truck is alleged to do, and the development of the state system for the great majority of car owners who pay both car licenses and land taxes in the state, could be carried forward with greater speed.

Maintenance Organization

Maintenance work of the Connecticut Highway Commission is entirely divorced from construction, except for the accounting, which is done by a common organization. The maintenance department is in charge of a superintendent of repair. The system of maintenance closely resembles that employed by railroads. The state is divided into eleven districts and each district into a number of sections, the size varying with geographical character, intensity of traffic, availability of stone and other materials and type of road. It is essentially a "floating-gang" system, each section having a foreman and a gang of eight to ten men in summer and three or four in winter.

Almost the entire department of repair is motorized, each floating gang having its truck. Each section also has its own base or headquarters where are stored all the materials and equipment necessary for doing any sort of a repair job. Each district has its own pressure oil distributor, though mechanical hand spreaders are not used.

All of the men in the repair department are guaranteed yearly employment. If, during any season, the work slackens in one or a number of sections, the men are grouped to do such work as laying telford base, graveling, crushing rock, etc.

Equipment is furnished the various section foremen through the submission every February by them of a list of needed materials. These statements are received by the superintendent of repair and a blanket bid called for.

As a safeguard against running short of road oil, the department of repair has had constructed in strategic parts of the state and at railroad sidings oil-tank stations, seven of which are now in operation. The total capacity of these stations is approximately 200,000 gal. each containing, usually, four 6,000-gal. tanks with some barrel storage, or three 8,000-gal. tanks, together with barrel storage.

In reviewing Connecticut highway practice, it is hard to see beyond the big consideration—traffic. "Give us an idea of the intensity and weight of traffic we will have to design for and we will build the roads to carry it" is an oft-repeated phrase in Connecticut. The motor truck has become there a structural as well as an economic problem.

Rhode Island's Practice

TAKING the people into his confidence and showing them reasons for this or that improvement, or for other lack of improvement, is a cardinal principle with the chief engineer of the Rhode Island State Board of Public Roads. Add to that the personal attention that he gives every new project, whether new construction or reconstruction, and the painstaking care with which the subgrade is studied and drainage facilities are provided, and the result is found in the remarkable success Rhode Island has had in the construction of that type of road for which she has become well known—bituminous macadam. These features, together with the large reconstruction program—as against new construction—that is being carried forward, form a review of highway practice in Rhode Island.

Though the care given the subgrade has been set forth in detail in *Engineering News-Record*, Dec. 11-18, 1919, p. 976, a recapitulation of the main points stressed is not amiss. When any piece of work is contemplated, the subgrade, whether it be old waterbound macadam or virgin soil, is inspected during the winter and again in the spring when the frost is coming out of the ground. Necessary drainage structures, the needed foundation depths, etc., have as their bases these observations—invariably made by the chief engineer and his principal assistant.

Subgrade Studied

If the new surfacing is to be laid on waterbound macadam, the weak spots in the existing road are pretty well known. If the work is to be a re-location, greater study is evidently necessary. The division engineers must be able to see suspected subgrade troubles and tabulate them. During the winter road examinations, hydrographic properties of the soil are noted. In the spring, subsoil defects that would not appear in the winter are revealed. With these data as a background the design for the foundations is drawn and weak spots are corrected by the laying of deep courses of telford or broken stone, gravel filled. All of the design and the making of specifications for each new improvement emanate from the office of the chief engineer. Only minor matters of policy or of structural detail are left to the division engineers.

Contracts for such improvements are intentionally let late in the season so that the work cannot be completed in one season. When the foundation is in, it is rolled intensively, sometimes during a period of two weeks. The road is then opened to traffic and further consolidated. To the following practices is laid the success of bituminous macadam in Rhode Island:

1. The greatest care in the selection of stone.
2. The use of a hard asphalt, from 90-100 penetration.
3. The securing of the maximum mechanical bond before any application of bitumen.
4. The greatest attention to rolling.
5. The extensive backrolling after the seal coat has been applied.

The statement has been heard that Rhode Island can secure successful results in penetration work due to the uniformly good quality of the subsoil. Yet it is a fact

Rhode Island has a most variable subsoil, and the traffic upon its trunk line highways is as intensive as on most sections of the Lincoln Highway in Pennsylvania.

Out of 75 miles of such construction in the state system, as a result of the heavy winter of 1919-1920, only two blow-ups in the surface were found. One of these was so slight as hardly to be noticeable and the other required rebuilding. And in rebuilding it *the subgrade weakness was corrected by tearing up the entire road at the point of failure and putting in a heavier foundation.* The surface was not merely patched.

Reconstruction Program

Between the years 1912-1919 hardly a cent was spent in Rhode Island on new work. When the present board began to function it fell heir to a system of highways in a bad state of repair. Reconstruction was essential before any extension of the designated state system was undertaken. An elaborate plan for reconstruction was started in 1916 and has continued since that date. Money for new construction is supplied by direct legislative appropriation, and that for reconstruction and maintenance by automobile license fees, augmented by a small general tax. The 1918 session of the legislature made available for new work $250,000 for each of the years 1919, 1920 and 1921. A large part of the work based on that expenditure has already been done. In contrast to that amount for new work, the money available this present season for reconstruction and maintenance has been approximately $1,000,000.

Beginning with the year 1916 the state had enough money either to put in moderate repair most of the roads in the state system or to begin general reconstruction on a more permanent basis. The latter course was pursued. Most of the money available that year was used in putting in penetration roads with the result that road users were educated to the advantage of steadily building the modern-type surfaces.

Distribution of an intensive commercial motor vehicle traffic to avoid congestion particularly at centers of population, has given Rhode Island a serious problem. The state system as originally constructed gave rise to existence of numerous inter-village roads which were not always the most direct routes. The plan of highway extension now contemplates the construction of direct routes between points through which through-traffic goes. Reconstruction money might be used to put into shape these inter-village roads that are often circuitous and which, near towns, if used by through traffic, become congested. But, with the construction of new through routes, through traffic will avoid villages and enough money will remain to maintain inter-village roads for a greatly reduced traffic which is more or less local.

Original Plan

When the present chief engineer of the board began his program of reconstruction he contemplated first making the foundation permanent. Money was not available for general construction of the highest pavement types. Funds had to be expended most judiciously and some type of surfacing had to top the permanent grade. Bituminous types, particularly penetration macadam, were chosen with the belief that renewals would be necessary at least inside of ten years, and that the highways thus constructed would, after three to five years, become increasingly expensive to maintain. During the life of these pavements it was presumed that more would be known of the ultimate traffic highways would have to bear, and more adequate designs would have been created. However, so satisfactory have bituminous macadam roads proven, and so successfully have they withstood both climatic rigors and heavy traffic, that the experiment is becoming general practice.

As elastic a system of maintenance as possible obtains in Rhode Island. In general, truck patrol is used in work upon waterbound macadam, and the floating gang patrol, working out of the several division headquarters, operate in bituminous work. In addition there is a "flying squadron" which does hurry-up jobs. Due to the smallness of the state such elasticity of organization and control is possible.

Because so many of the highways are closely dotted with manufacturing communities, sub-surface installations and, consequently, pavement cutting are frequent. So far replacing such cuts have formed the major part of the maintenance work on bituminous roads.

If patching be necessary, when the weather will not admit of the application of a hot patch, a cold patch is applied. The instant a cold patch shows the least sign of deterioration or failure it is ripped up. In its place, and in general maintenance practice, the same materials as went into the original construction of the pavement are put into the patch, and in the same proportions.

Aside from the impression of co-operation, centralized control, and personal attention to each new piece of work, which makes the position of Rhode Island unique, two remarks of the chief engineer of the State Board of Public Roads embody the high lights in construction and maintenance practice:

"It is a public crime not to build roads right in the beginning"; and "maintain the integrity of the particular type of road built by putting in patches of exactly the same materials as went into the original construction."

Massachusetts Practice

HIGHWAY thinking in Massachusetts is centered about one problem to which all others are subordinated—motor-vehicle traffic intensity, with which goes the question of truck-weight determination. Perhaps in no other state has the traffic problem become more acute. Massachusetts presents some daring thought in the matter and is convinced of the early necessity of determining maximum loads that highways ultimately will have to bear. Important as this problem is, general consideration of design and construction, and special reference to organization and finance, must not be overlooked in reporting upon Massachusetts practice.

Massachusetts is about 200 miles from east to west and 50 miles from north to south. It has a population of approximately 4,000,000 centered mainly in 214 towns and 38 cities, the latter of more than 15,000 population. The state possesses a diversity of manufacturing industries that demand adequate transportation facilities. It has a state highway system of 1,500 miles of all types, a large proportion being waterbound macadam. It has registered this year 225,000 passenger cars and 50,000 trucks, in round numbers. Of the trucks 70 per cent are of one-ton capacity or less, 20 per cent one and one-half and two tons, and the remaining 10 per cent above two-ton capacity.

In Massachusetts, as in Connecticut, the small proportion of registered vehicles comprises those for whom expensive construction must be provided if no limitation is to be put upon the ultimate truck load. However, Massachusetts presents an accentuated case inasmuch as the ratio of heavy trucks to all other cars is so small.

Massachusetts a Pioneer

Massachusetts is the pioneer roadbuilding state. As early as 1894 a highway department began construction upon a definite system. Roads were then desired for a slow-moving traffic of rarely more than three tons. One lane of travel was usually provided. With the intensive development of the motor vehicle and the consequent crowding of the highways with heavy and light units, it has been found impossible to save much of the waterbound macadam. Particularly on trunk-line arteries have heavier bases been needed. A repetition of this loss through unreasonable demands made by a very small minority of highway users, particularly if increasingly heavier units are to be designed and built, is feared. It is to obviate this loss that Massachusetts is found among the leaders in that highway thought which demands utmost consideration and co-operation from the automotive industry in a speedy determination of the ultimate maximum loads to be carried by commercial vehicles.

With the problem of weights disposed of through universal limitation, traffic congestion must be relieved through widening existing highways and extensions of the state system. The state is seeing more and more the necessity of 20- and 22-ft. metalled widths for trunk-line routes. Prime considerations in construction are believed to be drainage, base, alignment and grade, in the order named. Experience has taught Massachusetts that a road, excluding the surfacing, must be made permanent in the beginning. The accommodation of traffic through good alignment, and grades not to exceed 7 per cent where economically possible, is sought.

When the first system of roads was constructed in Massachusetts, highways were built to interest the towns, therefore the work was done close to towns. The state system, until comparatively recently, presented no connecting system of highways. When the laying of modern types became imperative it was found many connecting links had to be constructed. The old highways, too, needed attention and as many of these were not on the new state system, maintenance of them became a problem, inasmuch as the villages and towns near were too poor to undertake their maintenance alone.

State Aid for Town Roads

To meet this emergency the legislature passed a law in 1918 setting aside a certain portion of the motor-vehicle tax for town-aid use. A small contribution toward the maintenance of roads near it was necessary before any town could apply for state aid. The aid is given to towns whose valuation is not in excess of $3,000,000 and whose road mileage valuation is less than $50,000. The state may either do the maintenance work or superintend it, but it is responsible for the economic expenditure of the aid funds. It is hoped the act will so stimulate maintenance among the towns that within a few years a large percent of the deteriorated highways will have been restored.

In all the New England states there seems to run a common belief: That, to make the subgrade uniform and adequate is much better than to vary surface thicknesses to meet varying subgrade conditions. In Massachusetts this thought is expressed: We will make the foundation as permanent as possible now, and when the ultimate weight of commercial units is no longer a variable, our engineers will design an adequate surface. Stone block on a concrete base underlaid by a foundation of field or quarry stone, is now considered the most permanent type. Its expense, coupled with the knowledge that concrete and penetration macadam roads will carry, for a reasonable period at least, 90 per cent of the traffic, has eliminated stone block. However, if the taxpayers agree that provision should be made for the heaviest truck unit, stone block on trunk-line highways costing from $100,000 to $150,000 per mile is not an impossibility.

In designing and carrying out new construction, Massachusetts pursues an unique course. Many of the men in the division of highways have been in state highway service for years. Three of the four district engineers have been with the department for 25 years and the fourth 20 years. The chief engineer has had more than 10 years service and many of those occupying subordinate positions are old in the employ of the department. This service has had a marked effect on the method in which construction projects are undertaken. The district engineers, who are acquainted with every foot of the highways within their respective territories, design drainage structures, foundation courses and bases. What surfacing is to be used is decided upon by the chief engineer in consultation with the highway board. The amount of traffic that any road will have to carry is approximated through the traffic counts that were taken upon practically all the highways in the state system in 1910, 1912 and 1915, and the count made at strategic points in 1918. Besides being responsible for foundation, base and drainage design, the district engineers superintend all maintenance within their districts.

The three states of Connecticut, Rhode Island and Massachusetts, small, densely populated, and housing manufacturing establishments of every- description; where inter-mill truck hauls are general, and where traffic problems have become in a measure those of the thickly populated city, are confronted, perhaps more than any other section of the country, with the necessity of making determinate the ultimate maximum truck loading, so that the accommodation of all traffic may be secured through the construction of highways based upon known loads.

Large Bridge in China to Be Replaced

News of the calling of bids for a very large bridge reconstruction is given in *Commerce Reports* of Nov. 29, after a cablegram of Nov. 27 from Commercial Attache Julean Arnold at Peking. The Chinese Ministry of Communications is about to issue specifications for a new bridge over the Hwang-Lo or Yellow River on the Peking-Hankow Ry. The present bridge, regarded as inadequate, is 9,875 ft. long, partly of through truss and partly of deck girder construction, supported on screw piling, and is only 11 ft. above high water. It was fabricated in Belgium and France. The capacity of the old structure is stated to be little if any greater than Cooper's E-35. The new bridge is to be built for E-50. Its cost is expected to range from $15,000,000 to $20,000,000.

An Automatic Recording Apparatus for Stream Discharge

BY GEORGE HOLMES MOORE
Hydrographer, City Engineer's Office, Seattle, Wash.

WHILE the machine containing the Moore stream-discharge plotting attachment is the first universally adaptable stream-discharge recorder, it is in the attachment itself that the essence of the invention lies. Those who are familiar with the standard types of stream gage-height plotters—the Gurley, Friez, Stevens and similar ones—know that previous standard practice has sought to secure a continuous record of gage heights rather than a record of actual stream discharge. The machine itself will differ very little in outward appearance from any of the standard forms of the well-known Stevens water-stage recorders, and in fact the attachment was developed for use with a Stevens Type A which has been operating on the Skagit River at Reflector Bar for some years past.

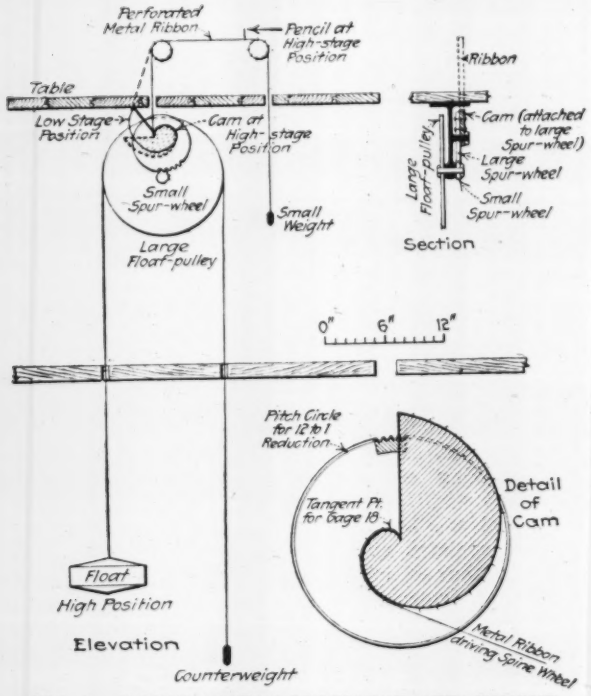


FIG. 1. MOORE STREAM-DISCHARGE ATTACHMENT TO WATER-STAGE RECORDER

The attachment (Fig. 1) consists primarily of a simple cam specially designed for each station, operated through a pair of reducing gears by the float-wheel of the standard water-stage recorder. This cam actuates the recording pencil directly by means of a perforated metal ribbon similar to the endless belt now used on the standard. Remembering that the sole function of the two spur-wheels is to secure a 12 to 1 reduction of the float-travel, the simplicity of the device becomes evident. It will be seen also that the pencil travel, at the high-stage position shown in the cut, will be much less than 1 in. per foot of float travel, a point which will be discussed more fully later on. It is clear that the recording pencil, as actuated by the metal ribbon attached to the cam, will produce a record widely different from that of simple gage heights.

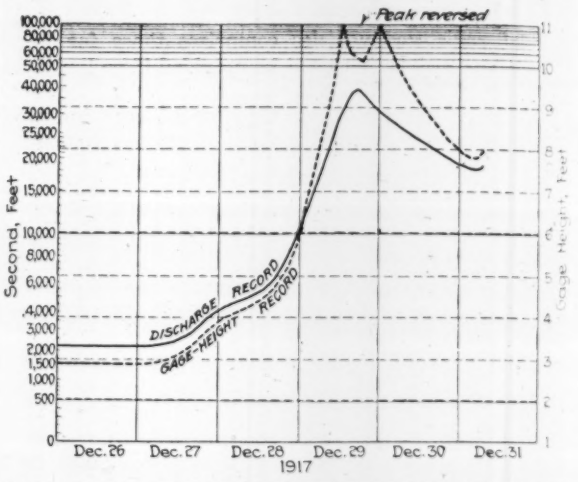


FIG. 2. FLOOD CONDITIONS OF SKAGIT RIVER AT REFLECTOR BAR, WASHINGTON, DEC. 26 TO 31, 1917

Two sheets here combined in one by superimposing the gage-height record on the discharge record. The peak load in the gage-height curve is inverted, due to one of the "dreaded reversals" mentioned in the text.

The particular cam shown was designed to fit the rating curve of the Reflector Bar station on the Skagit River; and it may be of interest to note that in its development, a new cross-section paper for hydrographic work was evolved, the characteristics of which will be presented further on. It should be pointed out, however, that experience already obtained indicates that no difficulty need be anticipated in the design of a similar cam to fit any rating curve whatever; since it is only necessary to so proportion the cam dimensions that the recording pencil will travel, on the new hydrographic paper, from the discharge value, as indicated by the rating curve for, let us say, gage height 9 to the discharge value as indicated by the same curve for gage height 10, while the float rises the distance of a foot, and the pitch circle of the large spur gear moves through the distance of one inch.

A cam-driven discharge record is shown in Fig. 2, contrasting strongly with the standard type of gage-height record shown in the same illustration. It will be noted that the gage-height record shows one pair of the dreaded reversals which, in actual practice, often mean a broken drive ribbon and the loss of the important flood record; and this in spite of the very ingenious design and workmanship found in the Stevens reversing mechanism. Furthermore, if the flood here recorded had found the machine operating on the smaller float wheel, as it usually is, there would have been two pairs of these reversal points instead of one.

In this connection it may be well to point out the four objects sought in the development of the discharge plotter: (1) A record of discharge instead of stage; (2) elimination of reversal points; (3) contracted scale for high-stage record; (4) expanded scale for low-stage record.

A comparison of the two curves in Fig. 2 shows that the first two objects are attained by the discharge recorder. However, the attainment of the very important object (4) is better shown in Fig. 3, which was designed for the duplex type of Stevens with a 20-in record. Here it is demonstrated that the pencil travel

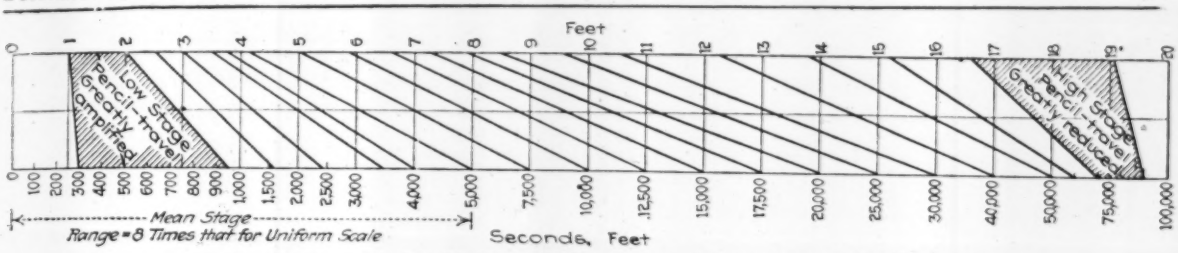


FIG. 3. DISCHARGE OF SKAGIT RIVER AT REFLECTOR BAR, FEBRUARY, 1920

for the plotting attachment is two and a half times as great as that for the standard water-stage recorder. Also, it is evident that pencil travel for high-stage conditions is correspondingly reduced, as specified in object (3).

Fig. 3 also shows the elimination of a serious obstacle met with in previous attempts at discharge plotting. Thus, if a discharge of 100,000 sec.-ft. is to be plotted on straight-line cross-section paper, all discharges up to 5,000 sec.-ft. would be recorded in a single inch of a 20-in. record. And, on this basis, the entire record at Reflector Bar for the seasonal year of 1915 would have been compressed into that inadequate space. With the Moore attachment and the new hydrographic paper this discharge record would be spread over no less than 8 in. on the 20-in. ribbon, or 4 in. on the 10-in. This would be approximately twice the size of the standard water-stage record for the Reflector Bar station, as will be apparent from further study of Fig. 3.

Since there will be some who feel lost without the familiar gage heights it may be noted that it is quite possible to have the same machine record both simultaneously. The Stevens duplex recorder is admirably adaptable to this purpose.

Before proceeding with a description of the new hydrographic paper it may be well to answer in advance some objections to installing a discharge recorder instead of the type previously standard. Thus, one engineer of eminence has urged that such a device should never be installed upon a new station, or indeed upon any station except those rare ones where the rating is not only perfectly established but also where it never "shifts." As a matter of fact, if the new cross-section is used for the record paper a new station is just the place where the discharge plotter should be used; for in that case the recording pencil can be set directly upon the proper discharge as soon as the first stream measurement has been computed. The accruing advantages which will result will become more intelligible from a more intensive study of the new paper.

In the search for this cross-section paper it was stipulated at the outset that the ordinates should correspond to a variation of 500 sec.-ft. for the first inch, of 5,000 sec.-ft. for the middle or fifth inch, and of 50,000 sec.-ft., for the last or tenth inch; and that the whole range of variation should follow some regular curve. It was not known that such conditions were possible of fulfillment, but the straight cross-section had been discarded, and the semi-logarithmic, while much better than any other known section, was unsatisfactory in that it never came down to zero.

It was found that the conditions were sufficiently complied with by the Spiral of Archimedes (American Civil Engineers' Pocket Book, 2d ed., p. 1162) and it was later discovered that when plotted on such a paper the Reflector Bar rating curve became a close approximation to a straight line at 45 deg., which is the ideal type for a rating curve. Upon later study it became gratifyingly evident that many other ratings would approximate the condition of a straight line at 45 deg., with only a little care in the choice of gage-height scale. Still later it became apparent that the entire discharge history of any river or stream could be plotted upon a single sheet of such cross-section paper without losing any of the advantages of accuracy and legibility in the low-stage portions of the record. With the possible exception of the semi-logarithmic paper previously mentioned this cannot be done with any paper which has thus far come to the writer's attention. A sample sheet of this new hydrographic cross-section paper is shown in Fig. 2, previously mentioned. The original of this sheet, however, is ruled to only 200 abscissa divisions while 400 are required for the annual studies

Large Activated-Sludge Installation at Reading, England

AN ACTIVATED-SLUDGE plant designed to deal in the future with 4,200,000 U. S. gal. of sewage per day has been designed for Reading, England, and the plans have been approved by the Ministry of Health. When the work is completed, we are informed by T. Midgley Taylor, Westminster, England, engineer for the plant, that this will be the largest activated-sludge installation in England, and Reading will be the only large town the whole sewage of which is treated by the activated-sludge process. The sewage of Reading is now dealt with on a sewage farm without any preliminary treatment, as it has been for many years past. (See editorial note, Nov. 25, p. 1018.) Since Reading is situated on the River Thames, above the London water-supply intake, Mr. Taylor states, a very high degree of purification is insisted on, and in consequence the farm is to be maintained for further treatment of the effluent from the activated-sludge plant in case that should be necessary.

The present dry-weather flow of sewage at Reading is about 3,300,000 U. S. gal. This comes from an absolutely separate sewerage system, into which practically no rain water is admitted and which receives only a small percentage of trade wastes. Consequently, there is very small variation in the rate of sewage flow.

The new plant will consist of screens and detritus chambers, four aëration tanks to be used in series, but each capable of being isolated, the four having a total capacity of 2,100,000 U. S. gal.; two settling tanks with a total capacity of 540,000 U. S. gal.; sludge storage tanks with a total capacity of 180,000 U. S. gal.; and a re-aëration tank with a capacity of 312,000 U. S. ga' Electrically-driven air compressors will be installed.

Variable Speed Induction Motors for Centrifugal Pumps

THAT a large saving in the power required to drive centrifugal pumps might be made if designers and operators would employ variable speed drive to control pump discharge and not rely entirely on throttling is the conclusion to be drawn from a paper by Prof. Melvin L. Enger and William J. Putnam, University of Illinois, presented before the Illinois Section of the American Water Works Association. The authors first discuss the centrifugal pump as "inherently a variable speed machine" and outline conditions under which pumps operate, as follows:

Fig. 1 shows the relations between the quantity, head and speed in the case of a typical machine; when any two of the three variables are selected the third is determined. For example, if the speed and quantity are chosen the head is fixed. With the usual arrangement of an induction motor direct-connected to the pump, the speed is fixed. True, the speed of an induction motor is not quite constant, decreasing with increasing loads and affecting the relation of the head and quantity delivered by the pump somewhat as indicated by the dotted line in Fig. 1, but the variation in speed is so small, however, that this drive is usually considered to be a constant-speed machine.

There are four general conditions under which pumps operate: (1) constant discharge against a constant head, (2) constant discharge against a variable head, (3) variable discharge against a constant head, and, (4) variable discharge against a variable head. The first condition is the ideal one for centrifugal pumps driven by constant speed motors. Pumps delivering water to filter plants or to surface condensers often fall into the second class. The third condition is probably a rare one. In the fourth class would be included pumps used in water-works plants for delivering water into distribution systems, because in this case variations of the water level in reservoirs and elevated tanks cause the head to vary, while variations in demand cause the quantity delivered by the pump to vary. In the last three cases it is customary to select motor-driven centrifugal pumps operating at constant speed which will operate satisfactorily under the most adverse conditions, and to control the head and discharge by valves at all other times.

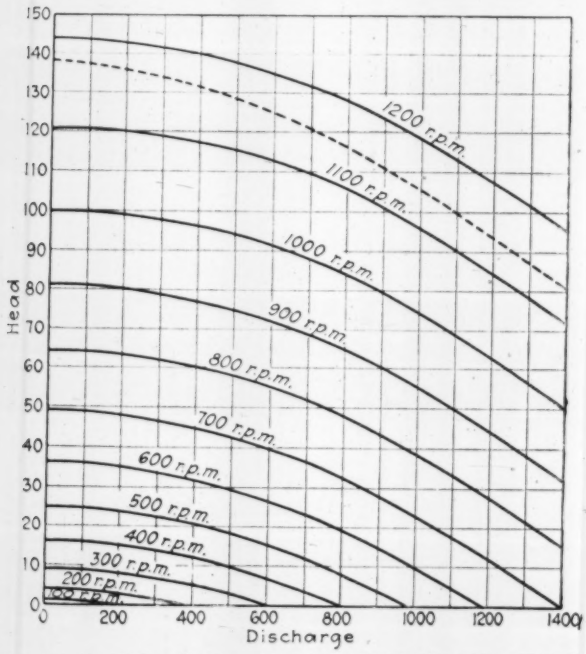


FIG. 1. SPEED, DISCHARGE AND HEAD RELATIONS FOR A TYPICAL CENTRIFUGAL PUMP

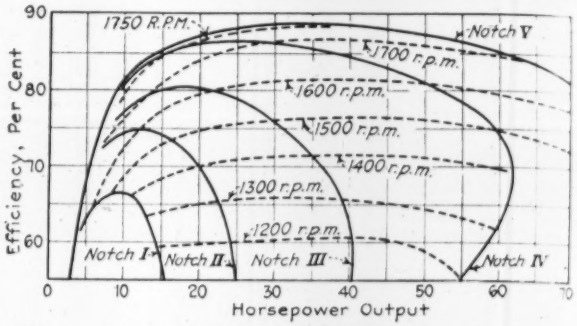


FIG. 2. EFFICIENCY AND SPEED RELATIONS FOR A VARIABLE-SPEED INDUCTION MOTOR
440-volt, 60-cycle, 2-phase, 50-hp.

The ordinary variable-speed induction motor has a wound rotor with its terminals connected to slip rings so that resistances may be introduced into the rotor circuit to change the speed. The action is somewhat analogous to slipping a clutch to secure lower speeds.

The authors next state that continuous running of a slip-ring motor with resistance in the rotor circuit is not widely advocated because it decreases motor efficiency and capacity, but in the special case of driving a centrifugal pump, the net efficiency of the unit is greater than running at normal speed with the pump throttled. The greater the resistance the more the speed falls under load; but at no load the speed is practically normal, or synchronous, whatever the amount of resistance in the rotor circuit. The energy lost in the resistance is proportional to the speed reduction—that is if speed is decreased 30 per cent below normal 30 per cent of the energy drawn from the line is lost. The remainder of the paper is given substantially as written:

Fig. 2 shows the relations between horsepower output, efficiency and speed of a 50-hp. Westinghouse variable-speed induction motor used for driving a DeLaval three-stage centrifugal pump in the Hydraulic Laboratory of the University of Illinois. The results of the test of this motor bear out the statements made above.

When the head developed by the pump is in excess of the head required under the given condition of speed and discharge, the excess head is usually wasted through a partly-closed valve. The power input to the pump remains unchanged because the pump continues to deliver the given quantity of water against the same head, no matter how much the valve is throttled. The power used in producing the excess head is wasted. If, however, the speed of the pump is reduced to the proper amount it will not be necessary to waste head through a valve. The head developed by a centrifugal pump varies as the square of the speed when the discharge is zero, and varies approximately as the square of the speed for any discharge within the usual range of operation. If the speed is reduced to 90 per cent of the original speed the head will be reduced to about 81 per cent of the original head. If this change of speed is accomplished by means of a variable speed induction motor, the efficiency of the motor will be reduced to 90 per cent of the original efficiency. The efficiency of the pump usually does not change materially within such a range of operation. If the head is reduced to 81 per cent of the original head by throttling a valve the over-all efficiency will be reduced to 81 per cent of the original over-all efficiency. That is, the use of the variable-speed motor to decrease the head to 81 per cent of the original value reduces the over-all efficiency by 10 per cent, as compared with a 19 per cent reduction in case a valve is throttled.

In the case of a motor-driven pump having an over-all efficiency of 55 per cent, delivering 1,000 gal. per minute against a maximum head of 100 ft., but operating against a head of 90 ft. half of the time, a saving of about $150

a year would be effected by the use of a variable-speed induction motor instead of a squirrel-cage motor, it being assumed that power costs 2c. per kw.-hr. Approximately the same saving per year would be effected by the use of a variable-speed motor with a pump of the above capacity and efficiency for any maximum head provided that the pump operates half of the time at a head of 10 ft. less than the maximum.

Fig. 3 gives the results of tests on a DeLaval three-stage centrifugal pump direct-connected to a Westinghouse variable-speed induction motor. The over-all efficiency of the unit when delivering various quantities of water against various heads is shown when the speed of the unit is varied

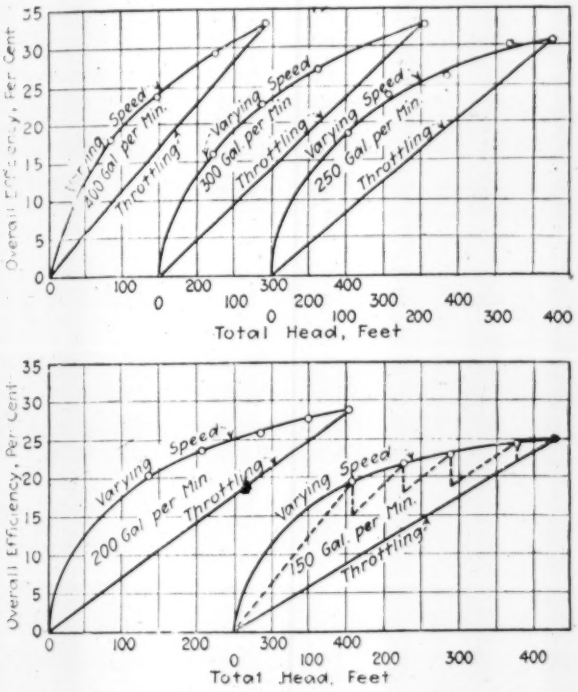


FIG. 3. COMPARISON OF OVERALL EFFICIENCIES FOR A CENTRIFUGAL UNIT

From tests on a motor-driven three stage pump run at normal speed throttled or variable speeds unthrottled.

and also when the unit is run at normal speed and the heads are obtained by throttling the discharge valve. It will be noted that the saving in power effected by the use of the variable-speed motor is large when considerable reductions of head are required. The motor driving the pump was arranged for only five running speeds. The smooth curves drawn through the points indicate the over-all efficiency if the resistances introduced into the rotor circuit could be made any desired amount. For the unit used in the tests it is necessary to throttle the discharge valve to obtain heads between those given by the five running speeds. The over-all efficiency for different heads is therefore as indicated by the dotted lines in the tests with the discharge of 150 gallons per minute.

In the selection of a variable-speed motor to drive a centrifugal pump great care should be taken that the several speed changes shall all be within the range required to produce the specified range of head, and the more speeds within this range the better. The electrical manufacturing companies might well turn their attention to developing an external resistant having a large number of steps.

The resistances consist of cast-iron grids compactly arranged, and are connected with the motor through a controller of the type used on street cars. Considerable heat is developed in the grids when the motor is operated at the lower speeds. The grids should therefore be located where the heat generated will not be objectionable. Unless the operator is instructed concerning the advantages of the use of variable speed he is liable to conclude from the heat developed in the grids that it is better to throttle the discharge by means of a valve, because the energy loss in this case is not so apparent, although it is an general about twice as great.

The variable-speed induction motor is more expensive than the ordinary squirrel-cage motor, but the saving in power resulting from its use, when the head varies considerably, will much more than pay the interest and depreciation on the additional investment.

Pipe Line System of Oil Transportation

A FEATURE in the development of the oil industry in this country has been the introduction of long pumping mains for conveying oil from the producing districts to the oil refineries, these lines dating back about 56 years and aggregating now about 45,500 miles, according to a paper by C. P. Bowie, petroleum engineer for the U. S. Bureau of Mines. Of this total, 34,000 miles are truck lines, usually of 8-in. pipe; the remaining 11,500 miles are gathering systems of 4 or 6-in. pipe from the tanks at the wells to those at the head of a trunk line. These gathering systems may be owned either by the producers or the trunk line companies. This method of transportation has largely superseded other methods owing to the low cost and has made it possible to establish refineries near the large consuming centers instead of in the remote producing districts. When most of the trunk lines were built the cost averaged $6,500 per mile of 8-in. line and $130,000 to $250,000 for each pumping station, the present fixed investment being estimated at $500,000,000.

Threaded steel pipe is used, the 8-in. pipe for trunk lines being designed to withstand a 2,000-lb. pressure and carrying a working pressure of 700 to 900 lb. In locating a pipe line, rough country and swamp land are avoided as far as posisble. For a private right of way, land may be purchased or a permanent easement may be secured to give the owners of the pipe line free access to their property. In some states the land may be obtained by condemnation. For communication with the various stations the companies usually erect telegraph and telephone lines along the right of way, so that the men who patrol the pipe lines can also note the condition of the wire lines.

In construction work the right-of-way gang first clears the site, placing culverts or casings at railway crossings and if necessary building roads to facilitate the hauling of the pipe. Then comes the stringing gang, which distributes the pipe; this work often involves hauling material for long distances and over difficult country. When a considerable stretch of pipe has been distributed the pipelaying gang connects the joints; 40 men with pipe tongs will connect up from 2,500 to 4,000 ft. of pipe in a 9-hour day. A more modern method is to use a pipe jointing machine and 28 men with such a machine have connected up 8,700 ft. of pipe in a day. Next comes the ditching gang to dig the trench and lay the pipe; in some cases the ditching being done first, the joints being then made with the pipe resting on skids or sleepers over the trench. Where the cost of trenching would be excessive or when the soil is strongly alkaline the pipe may be laid on the surface, resting either on the ground or on sleepers. If necessary to bury it in such soil the pipe is coated with asphalt and while this is wet a layer of roofing paper is applied and covered with a second coating of asphalt.

Pumping stations are spaced at distances ranging from 1½ to 90 miles, the distance depending upon the topography of the country and the viscosity of the oil. In the eastern and western states the average spacing is about 35 miles but in California it is only about 12 miles owing to the relatively thick and viscous character of the oil. The pumping equipment depends upon the quality and quantity of oil to be handled but also upon the fuel and water supply conditions, both steam and internal combustion engines being used. With 700 to 900 lb. pressure on the line the pumps can deliver through an 8-in. pipe about 30,000 barrels of oil in 24 hours.

Forest Depletion and Forestry Policy

CUMULATIVE depletion of the forests of the United States is the result of destruction rather than consumption and is the fundamental weakness in the supply and cost of wood products, according to a report prepared by the U. S. Forest Service to comply with a Senate resolution. To offset this, the problem is to increase the production of timber by stopping forest devastation. At the present time, 60 per cent of the original timber is gone, timber is being used four times as fast as it is grown, the forests remaining are so localized as to reduce their national utility, and the bulk of the population and manufacturing industries are dependent upon distant supplies of timber as the result of depletion of the principal forest areas east of the Great Plains. The above summarizes the main findings of the report, which are supported by a mass of detail and statistical matter. A shortage of lumber supply after the war was combined with a sudden demand for material for dwellings, industrial structures and manufacturing industries. But with labor difficulties, car shortage, bad weather and speculative conditions, the lumber industry was unable to respond to the demand. As a result the market has been unstable and prices have reached unprecedented heights.

Depletion of timber has been an important contributing cause of these excessive prices, and it has led to the migration of both the softwood and hardwood lumber industries from region to region, while the exhaustion of local resources has compelled many large lumber consuming centers to import their supplies from increasingly distant points. This last feature results in increased cost of transportation which is represented in increased price. Export of timber is not an important factor as to quantity, but has a direct bearing upon the duration of the limited supply of high-grade timber, especially hardwood.

Devastation of timber supplies and failure to utilize land for growing timber are the main causes of the depletion, actual use of the forests being but a small factor. A national policy of reforestation is urged by the report as the solution of the problem of insufficient timber supply. It is stated that if the enormous and increasing idle areas of forest growing land which are not required for other economic use, now aggregating 463,000,000 acres, can be restored to timber growth, they will assure a future supply of forest products adequate to the needs of the country. The forestry policy advocated in the report is based upon concerted action by the Federal government, the state governments and the landowners. It provides for protection and conservation of the remaining resources, public instruction, and recognition by the owners of forest lands of their responsibility in keeping these lands productive. This policy would aim at timber production as an established national practice, as in France and Scandinavia.

Houston Activated-Sludge Plant Results

CURRENT results of the operation of the Houston activated-sludge plant, as given by J. C. McVea, city engineer, at the recent convention of the American Society for Municipal Improvement are as follows: No difficulty has been encountered in producing a clear and unoffensive effluent. Fish have lived in the outlet chamber for more than a year. The sludge has greatly varying characteristics after pressing. At times it is so sticky that it will not drop from the belt conveyor. Suspended solids are reduced 96 to 98 per cent. The relative stability obtained by incubation for 10 days at 37 deg. C. ranges from 86 to 98 per cent. Oxygen consumed varies from 50 to 81 per cent, averaging 65 per cent. Free ammonia in the raw sewage, 15 to 18 parts per million, is reduced quite uniformly to 5 parts in the effluent. The air used is 1.44 cu.ft. per gallon treated, the main aëration process utilizing twice as much air as the re-aëration. The average time for the aëration is 2 hours and 15 minutes and for the re-aëration 4 hours and 40 minutes. The cost of handling 1,000,000 gal. of sewage is $14 exclusive of overhead and treatment of sludge. The 12,000,000-gal. plant is operated at one-half capacity. Notes on these plants, obtained by a member of the editorial staff, appeared in *Engineering News-Record*, Dec. 11-18, 1918, p. 1003, and forms used for recording operating results were printed Jan. 8, 1920, p. 75. The larger of the two plants was described in *Engineering News*, Feb. 8, 1917, p. 236.

Rural Road and Bridge Expenditures

During the calendar year 1919, 46 States of the Union expended over $400,000,000 on their rural roads and bridges, the Bureau of Public Roads of the U. S. Department of Agriculture recently announced. This total is made up of the actual cash expenditures for such items as labor, materials, supervision and administration, amounting to $389,455,931, and convict labor and statute labor, the value of which, not definitely known, is estimated at about $132,000,000. So far as possible, all expenditures on city streets within incorporated towns and cities and all items of sinking-fund payments or the redemption and interest payments on road and bridge bonds have been excluded.

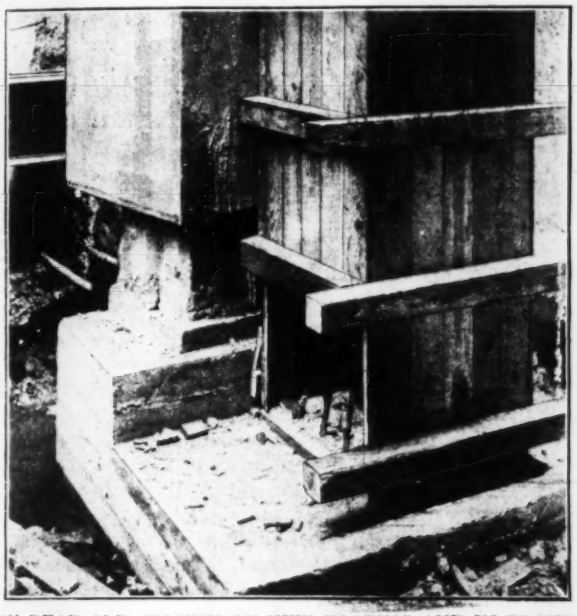
The road and bridge expenditures for 1919 show an increase of approximately 33⅓ per cent over those of 1918 and 70 per cent over those of 1914. More striking, however, is the increase in the proportion of the total funds supervised by the several State highway departments. In 1918 the expenditures by or under the supervision of the State highway departments amounted to $117,285,268, while the local road funds, over which they exercised no control whatever, amounted to $168,812,925. In 1919, however, the State highway departments supervised the expenditure of $200,292,694 as against the total of $189,163,237 expended by the local road and bridge authorities.

Underpinning a Concrete Building by Jacketing Columns

Weak Footings Replaced and Made Continuous With New Footings for Adjacent Columns of New Building

By R. L. Bertin
Chief Engineer, White Construction Co., New York City

THE construction of a new building adjoining the existing building of the Gates Plant of the Yawman & Erbe Manufacturing Co., Rochester, N. Y., necessitated the removal of the footings under the concrete



IN REAR OLD COLUMN ON NEW FOOTING AND IN FRONT FORM FOR NEW COLUMN

columns of the old building and replacing them with new footings of sufficient capacity to carry the loading from the old columns as well as the new ones. The old building was built some years ago and no record could be found which gave accurate details of the construction.

The old building is a three-story and basement reinforced-concrete structure of the beam and girder type. A number of cracks are present throughout the structure and the footings under the old columns were found, upon examination, to be very thin in proportion to their spread and set eccentrically with the columns.

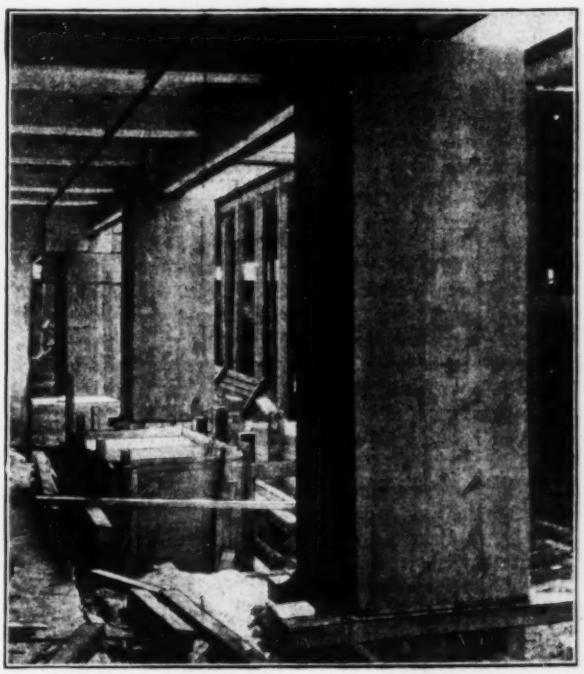
In view of the poor condition of the building it was essential that a method of shoring be adopted which would preclude any possibility of settlement and which would not cause undue stresses at the junction of the beams and columns. Taking into consideration the fact that the upper floors were occupied and could not be interfered with, that absolute safety was required at every step of the work and that the work had to be executed as economically as possible, the method finally adopted was to grip the basement columns with a reinforced-concrete jacket, to lift the jacket and with it the column, depending on the frictional resistance between the two to transfer the column load to the jacket.

The old basement columns were roughened and horizontal V-grooves about 1 in. deep, 2 in. wide and 12 in. apart cut into them. The corners were rounded to a radius of about 3 in. A spiral of steel wire was wound around each column and held in place by vertical rods; forms were set around the column thus treated and a concrete jacket 6 in. thick cast around it. The jacket was kept clear of the spandrel beams and girders of the floor above and the bottom of the jacket kept about 18 in. above the top of the old footing.

Temporary footings were cast between the columns and carried down to rock, which was found at a level 2 to 3 ft. below the bottom of the old footings. In order to get proper elevation for the I-beams which were to carry the columns during the underpinning the temporary footings had to be built higher than the basement floor but they were cast with a horizontal joint so that the upper part above the finished basement floor level could be removed by simply wedging the upper sections off the lower one. This was considered better practice and more economical than to attempt any other form of blocking. The holes for these footings were sheeetpiled and braced thoroughly to safeguard against undermining the old footings.

Two 20 in. I-beams were set on each side of each jacket, bearing on the temporary foundations, from which were hung two 15 in. I-beams, set and grouted under the bottom of the column jacket, using twenty-four 1-in. suspension rods. The cradle thus formed was raised by taking up gradually on the suspension rods until the weight of the column was transferred from the old footing to the steel beams, a condition which was accurately determined when the main steel beams ceased to deflect and the column started to raise.

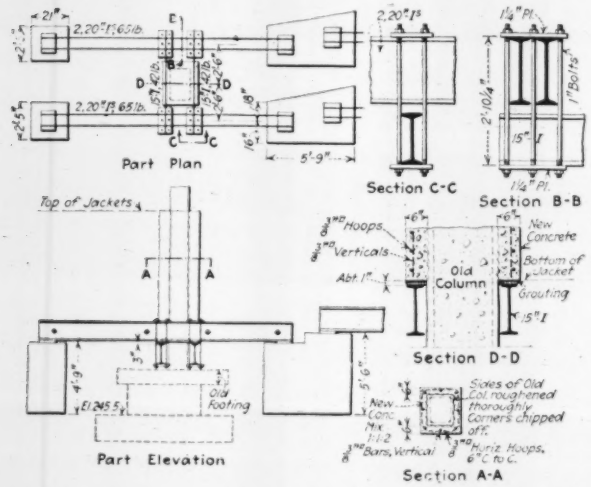
The dirt under the old footings was then excavated, the old footings were broken up and removed and the bottom of the old columns was dressed to a true surface. The new footings were installed and the space of about 3 in. left between the bottom of the old columns and the top of the new footings was grouted under pres-



CONCRETE JACKETS DO NOT REACH TO UPPER BEAMS

sure with a 1:1 mix of cement and sand, thoroughly rammed in. Three weeks after the jackets were poured the cradles were lowered and the steel beams removed. Accurate readings taken while the cradles were being lowered and for some time after showed absolutely no settlement of the columns.

The upper floors of the building were used continu-



DETAILS OF UNDERPINNING OPERATIONS ON YAWMAN & ERBE BUILDING

ously while this work was going on and only a small part of the basement had to be vacated during the operation.

The jackets were so designed that the shearing stress between the old columns and the jackets did not exceed 30 lb. per square inch and the bearing stress of the concrete jacket on the steel beams 500 lb. per square inch.

This building is being erected by the White Construction Co. of New York City, under the supervision of R. R. Tinkham, resident engineer for Smith, Hinchman & Gryllis, architects and engineers, of Detroit, Mich.

Quality of Electric Arc-Weld Steel Studied

Examination of a large number of specimens of the steel deposited in electrically arc-welded joints by the Bureau of Standards shows that this metal has mechanical properties like those of an inferior casting. In tension tests the metal showed low ductility, and all of the specimens examined, about 70, showed evidence of unsoundness in their structure, tiny inclosed cavities, oxide inclusions, and lack of intimate union. The investigators, Henry S. Rawdon, E. C. Groesbeck, and Louis Jordan, conclude that this unsoundness is a necessary consequence of the method of fusion as now practised, and that it is responsible for the deficiency in ductility of the joint metal. Microscopic plates found in the ferrite grains of the metal, which are not removed by prolonged heating, are believed to have relation to the nitrogen content of the metal. They are called nitride plates, but are considered unimportant as the breaks in tension testing were not affected by them. Both a "pure iron" electrode and a low-carbon steel electrode were used, with practically equal results. The composition of the material changed in fusion by elimination of carbon and other elements. The use of slight protective coatings on the electrodes did not appear to affect the mechanical properties of the arc-fused metal. The results are to be published in Technologic Paper 179.

Report on Richmond Borough Sewage Tests, New York City

Tank Treatment With Chlorination in Some Cases Indicated—Siphon Tank Favored—Sludge to Destructors

THE belated report on "Sewage Experimental Investigations at West New Brighton, Staten Island (Borough of Richmond), N. Y." recommends that tank treatment of the sewage of the borough be accepted under certain conditions as a satisfactory method of treatment, with chlorination in special cases. The "siphon tank" is recommended for localities where covered tanks will be necessary. For sludge disposal it is suggested that the waste steam and heat from the borough refuse destructors be used to dry the sludge and that thereafter the sludge be burned in the destructors.

Scope of Experiments

The report was made by Warren R. Borst, assistant engineer, under date of June 24, 1919 (printed but recently), and is approved by Theodor S. Oxholm, engineer in charge of the Bureau of Engineering of the Borough of Richmond. The investigations were authorized by the Board of Estimate and Apportionment of New York City in July, 1911. Most of the experiments seem to have been conducted in 1914-16.

The experiments were confined to (1) sedimentation in plain settling tanks, Imhoff tanks without and also with colloidors and a siphon tank; (2) disinfection of raw sewage with hypochlorite of lime and with chlorine gas; (3) sludge treatment by drying in vacuum and by digesting in separate tanks; (4) rate of reaëration of sewage when diluted with fresh water and when diluted with salt water. The plain sedimentation tanks were 11 ft. long, 6 ft. wide and 12 ft. deep. The Imhoff tanks were of steel, 11 ft. long, 6 ft. wide and 19 ft. deep. In order "to combine the principles embodied in the Imhoff tank with those of the Hampton tank" one of the Imhoff tanks was equipped with "furring strips, extending 4 ft. into the upper compartment," these strips being "spaced 6 in. c. to c. and so staggered that the sewage passing through the compartment would have opportunity to come in contact with the surface of the strips."

The reason for trying the "siphon tank" was, according to the report, that "many of the sewer outfalls in the borough are located in populated sections where it would not be desirable to have odors from a sewage-treatment plant." On this account it was decided to "study the action of a closed settling tank operated on the principle of a siphon for treatment by sedimentation alone." This tank is described and its operation summarized in the report as follows:

For this purpose a cylindrical steel tank, with a conical bottom (similar to the type described under the title of "The Kessel," Proc. Inst. Municipal and County Engineers, vol. XXXVI, p. 201, 1909) was constructed.

The tank at this experimental station was 12 ft. high and 4 ft. diameter, with 6-in. inlet and 2-in. outlet. Before entering the tank the sewage passed through a small grit chamber constructed of a 30-in. tile pipe set vertically, from which the 6-in. inlet, submerged about 14 in. in the grit chamber for a water seal, extended into the tank. This chamber also prevented floating materials, such as matches, corks, grease, etc., from entering the tank.

The outlet of the tank, located near the top, consisted

of an inverted conical funnel of sheet metal 2 ft. 6 in. in diameter at the base, to which was connected the 2-in. outlet pipe; this outlet extending into the outlet chamber the same distance as the inlet pipe of the grit chamber. A valve provided on this 2-in. outlet line permitted control of the sewage flow through the tanks. From the conical bottom of the settling tank a vertical 14-in. cast-iron pipe with a gate valve extended into a sludge receiving tank which was 2½ ft. deep and 2 ft. in diameter. The ends of the inlet, sludge and outlet pipes were all of the same elevation and therefore all had the same water seal. The difference in head was about 5 in.

To start the operation of the siphon tank all valves were closed and the tank filled with water. After filling, the valves of the inlet, outlet and sludge pipes were opened. The siphon action caused the sewage to flow. The "flow through velocity" in the siphon tank being very low, the solids settled through the sludge pipe into the sludge chamber under the tank.

This tank and its method of operation provided for immediate separation of the settled solids from the sewage and prevented septic action interfering with the sedimentation process. This tank was operated continuously for three months, November to February, treating approximately 12,000 gal. per day, with results as given in the following table:

	Storage	Corresponding Velocities Ft. per Sec. 6-in. Inlet	Tank	Per Cent Settling Solids	Reduction Suspended Solids
Maximum	2½ hr.	11 2	0 175	81	42
Minimum	50 min	2 44	0 039	57	34
Average	1½ hr	6 22	0 098	70	49

Conclusion

The conclusions and recommendations of the report, in view of local conditions in the Borough of Richmond, are given in the report as follows:

1. That the experimental results with respect to tank treatment may be summarized as follows:

(a) Tanks having a detention period of from 1 to 2 hours and velocities of flow of from 0.007 ft. to 0.015 ft. per second will remove from 50 to 60 per cent of suspended solids and from 30 to 40 per cent of oxidizable organic matter.

(b) Imhoff tanks provided with colloidors in the settling compartment with the sewage at this station gave a more stable effluent than the ordinary Imhoff tank.

(c) The siphon tank gave very satisfactory results and from our experience at this station it has shown considerable advantage over other sedimentation tanks, in that the settling solids are entirely separated from the flowing through chamber and can be treated or removed while in a fresh state and free from the disagreeable odors usually attending the disposal of sludge.

(2) That in the disinfection of sewage, chlorine gas is more efficacious than hypochlorite of lime, although either when applied in sufficient amount gives satisfactory bacterial purification.

(3) That the experiments in sludge drying, although not carried through to conclusive results, indicate that the sludge may be treated without creating a nuisance by separate digestion, by vacuum drying or may be made non-putrescible by aëration.

(4) Much work in the laboratories had been done on the effect of dilution of sewage in bottles. The investigations made in the large tanks at this experiment station gives the resulting effects of what may be expected from the minimum disturbance upon the surface of a body of fresh water, salt water and sewage dilutions in various proportions, as well as what may be expected when the surface is more violently agitated. These results show that the reaëration is decidedly rapid and uniform throughout the body of water.

The rate of which the reaëration of the foul liquid sewage (devoid of all oxygen) took place was very rapid and the results show what may be expected from the agitation of the sludge compartments of two-story tanks in assisting the digestion of the sludge and prevention of the accumulation of noxious gases.

Recommendations

(1) That tank treatment of the sewage of the Borough of Richmond be accepted as a means to produce effluents of such a character as to preclude the probability of local nuisances in the vicinity of the outfall sewers, but only on those outlets for which the flow of sewage is uniform throughout the year and which can be located at sufficient distance from any neighborhood so that any odor from the plant will not give cause for complaint.

(2) That all effluents should be discharged into the waters surrounding the Borough at such points as to avoid stagnation and where agitation by wind and other agencies will provide for rapid absorption of atmospheric oxygen.

(3) That in the vicinity of bathing beaches and shellfish beds, the tank effluent should be treated with liquid chlorine at the rate of approximately 10 p.p.m.

(4) That the siphon tank is thoroughly practicable and should be used in localities where covered tanks will be necessary. The sludge can be either removed from the lower sludge chambers before it has had an opportunity to become septic or they can be so arranged and equipped that the contents of the sludge chambers may alternately be thoroughly agitated for from four to six hours or such time that may be found sufficient to furnish oxygen to oxidize the organic matter. This tank is much more adaptable to locations where the population is not of a permanent character, such as summer resorts, where the variation of flow of sewage has a wide seasonable range.

(5) In the disposal of sludge in the Borough of Richmend, it would seem that by using the waste steam and heat from the destructors the sludge can be economically dried and burned with the garbage.

Submerged Tear in Ship's Side Repaired by Use of Caisson

Successful use of an outside caisson marked the repair of the tank steamer "Bradford," recently damaged below water line while passing through the Panama Canal. The shell plating and frames on the port side of the forepeak were badly distorted at about the 6-ft. mark and there was a vertical tear in the plate about 4 ft. long and 1 to 6 in. wide, as the case is reported in the *Panama Canal Record* of Nov. 3. The drydock was not available at the time, so that some method of making temporary repair had to be used. After removing all the cargo from the forward part of the vessel to bring the bow up as high as possible most of the injury was still below water level. A caisson was made to fit over the hull so as to inclose the injury and make it possible to work at it. The caisson was a strong wooden box with the top and one side open, the edges at the open side being shaped to the form of the vessel from a pattern made by a diver. The edges which were to rest against the hull were covered with a thick padding of canvas and oakum. The box was manoeuvered so as to bring the padded edges against the side of the vessel and the open top a foot or so above water, and then the water within the box was pumped out. In this condition the outside water pressure held the caisson tight against the ship. Working inside the caisson a plate was applied directly over the break, extending for some distance either side so as to restore the strength of the hull. For further strengthening a box was built inside the hull over the damaged portion and filled with cement.

Observations on a Pacific Coast Trip—Spokane

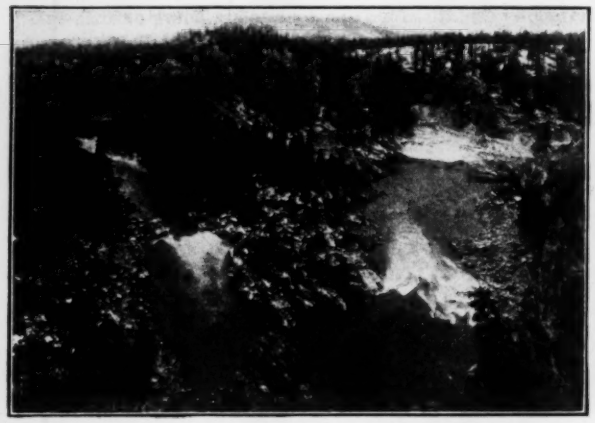
By Frank C. Wight
Associate Editor, *Engineering News-Record*

Mr. Wight is now on the Pacific Coast, studying engineering conditions. This is the first of a series of articles he will write recording his general impressions. Technical articles on outstanding developments will follow later.—Editor.

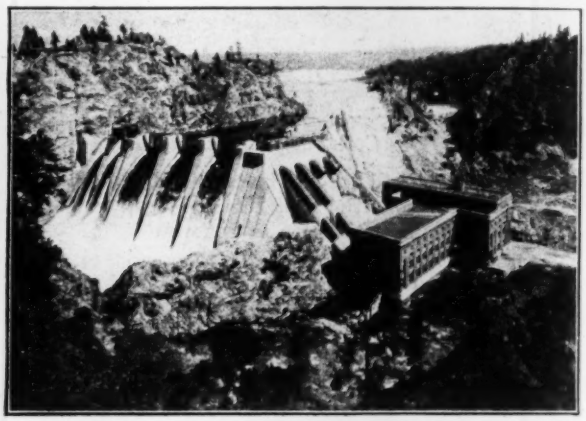
IF HUMAN qualities can be ascribed to a whole country or section of a country, it is safe to say that the West is distinctly masculine or, perhaps better, virile. It has those qualities of independence, resolution and courage that are a part of man. And yet it has at the same time one characteristic we are wont to think of as feminine. It is temperamental; it seems to delight in being misunderstood. What the East or what the rest of the country thinks of this West is quite another thing from what the West thinks the East thinks, but no amount of argument will convince the Westerner of that. For him there is a typical Easterner—and that means any one living East of the Continental Divide—who believes that Indians still roam the plains of Washington and that red flannel shirts are the favorite dinner costume of San Francisco. To translate that into engineering terms he feels that the Easterner—and particularly the coast Easterner—has not a proper understanding or a full appreciation of the truly Western problems and that in consequence the East, controlling as it does so much money power and government action, is not giving the West all it is entitled to as a producer for the country's general good.

To give a true engineering impression of the West, therefore, is a ticklish job. The risks of misinterpretation are great. It could be done, of course, by a dry record of achievement and prospects, by data and statistics, by detailed descriptions of projects under way or contemplated, but those matters will be left for other pages. These letters will be merely the random observations of an Easterner traveling for the first time through western country and studying by conversation and inspection the state of engineering as found in the principal cities, where engineers center, and in such of the big construction areas as can be conveniently reached. It is frankly written by one to whom the country is new—though the men met are often old friends—for such engineers as have not yet been there. To many this will be old wheat threshed.

After Butte, the first stop was Spokane, about twelve hours away. Boosters for the Washington city should arrange that every new visitor come into town from Butte on the sleeper, for after the bareness and ruggedness of the mining center, Spokane seems like a garden. Its own quite evident beauty of surroundings and setting is all the more emphasized by the lack of adornment of its far-away neighbors. The hills behind it are not so very high, judged by Rocky Mountain standards, but they are close and heavily wooded and the rivers which join at its outer boundaries have cut valleys that require a succession of bridges, from the little concrete arch, dedicated to the soldiers of the World War on Armistice Day, to the high and delicately traced Hangman's Creek viaduct which carries the Milwaukee out of the city to the west. In fact the first engineering impression of Spokane comes from its bridges. There are so many that the city's bridge engineer couldn't say off-hand just what the number was but there are at least a dozen across the Spokane River in the city proper. And though individually they are of high merit the growth of the city's needs has resulted in an intricate maze of bridge work about the Falls which is far from pleasing and certainly not economical. The fine Monroe St. arch, for instance, named just recently by a board of disinterested artists as one of the ten best pieces of architecture in the city, is so placed that from one side it is quite impossible to take a photograph of it from end to end. And the Post St. arch, a 215-ft. concrete structure of surprising flatness, is squeezed in between two other old steel bridges—one of which it could easily have supplanted—at an absurd angle.



SITE OF LONG LAKE DAM OF WASHINGTON POWER CO. NEAR SEATTLE



COMPLETED DAM AND 67,500 HP. POWER HOUSE AT LONG LAKE

The presence of the rivers and the Falls right in the city has resulted in another possibility of which no large eastern city save Rochester can boast. That is a water-power in the heart of the business district. For many years the Washington Water Power Co. has

operated an old, inefficient plant here, diverting water through a natural channel by a low dam. It is now planning to go farther up the river—about 500 yd.—and bring the water through a 70-ft. drop to a new power house which will generate about 15,000 hp. This company has many water-powers under operation throughout Eastern Washington and by a tie-line is connected east to the Montana Power Co.'s lines and west to those of the Pacific Coast Co., so that interchange is possible clear from Butte to the coast. One of the Washington company's latest plants, that at Long Lake, has one of the big dams of the near West—a gravity concrete structure 208 ft. high, with an installation of three 22,500-hp. turbines. As the two views herewith show, the dam site was rather remarkable. The right hand branch of the river has been stopped upstream by another dam and the main dam turned at right angles over the penstocks to extend the promontory which jutted out between the two branches.

Water Supply from Underground River

In the Spokane districts there exists a curious underground river which is utilized for the city water supply. The source of this flow has never been definitely established, though probably it comes from the Coeur d'Alène lakes, but it is a never failing current of unknown amount which may be tapped anywhere in the valley at a depth of about 3 ft. below the Spokane river, which level it consistently maintains. Three large wells have been driven for the city supply alongside the pumping station which used to take water direct from the river and without purification—for it needs none—is pumped to the varying pressures of the city mains. So far Spokane has not experienced any of the current apprehension regarding its water system, which is ample and pure. The only source of worry is some old small wood-stave pipe put in mainly by real-estate developments which are in bad order and need replacing.

So much for material things. Spokane is in the Micawber-like attitude of the rest of the country of "waiting for something to turn up." It has not suffered any great slump because it did not share greatly in the increased production of the war. Its contributory industries are fruit growing and farming and it looks forward to the irrigation of its lands east for its greatest future. The ambitious Columbia Basin Development—with its millions of acres and hundreds of millions of dollars prospective cost—comes down almost to its eastern gate and it sees there another Yakima Valley which from the West is turning toward Spokane millions of dollars of produce each year. Every engineer in Spokane talks about the Columbia Basin. Not all are confident that it will go through but everyone thinks it ought to go through and that the state and the Federal government should back it to the limit. Certainly one would be optimistic in believing that $300,000,000, the ultimate cost of the project, could be obtained from private sources, even though the opening of the land would provide for settlers facilities for producing enough food for the entire country.

In connection with the government irrigation help another phase of government aid is much talked of in Spokane. That is what some engineers are pleased to call government "interference", not government aid, for roads. Complaint is made widely that Washington—D. C., not the state—is too far away to handle the Federal-aid situation, that the Federal road engineers are arbitrary and insistent on too high standards for pioneer conditions, that the full purpose of the Federal-aid measure would be achieved if there were a government engineer located in the state, acting independently of the capital, but in conjunction with the state highway engineer. Needless to say this is gossip and not the opinion of any state official, but it is set down for what it is worth as one of the straws in the growing western opposition to centralization and government control.

Spokane's engineers are well organized. They have a fine, sympathetic association of the various engineering interests and societies which meets weekly at luncheon and frequently in the evening. In a quiet but effective way they are having an influence on the government of the city, which after all is one of the best functions of an engineering association.

One final word of warning to other cities. In the 1920 census Spokane was shocked to find that its preliminary figures were lower than in 1910, though obvious crowding and housing shortage made such a thing highly improbable. Judicious and careful counting managed to bring in enough to pass the decade-old figures, so at least the city is saved the disgrace of a loss in numbers, but the citizens are now hunting for the enthusiastic enumerators of the year 1910!

Bank's Comment on Construction Status

The National City Bank of New York, in a review of economic conditions made public on December 1, makes the following comment on the status of construction work:

Construction work has always led the way in recovery from business depression. The difference between good times is largely in the amount of construction work going on, and the strongest factor in the present situation is the amount of such work needing to be done. The country by all reports is underbuilt. None of the deficit of the war time has been made good, but last year and this year the country has fallen farther behind, because there is no confidence that present wage rates for mechanics or prices for material will be sustained in face of general business conditions. With great numbers of people out of employment, and the demand for office space and factory aditions falling off, investors are not wanting to put their money into building operations at costs which they believe can be very much lowered a year or so later. But if wages and prices come down so that building investments look to be safe against later competition there is a vast amount of work to go forward. There is no industry that holds such possibilities of help for the situation as house-building, for the materials required would give employment in a great variety of industries.

The railroads have a great amount of work to be done, and only need the encouragement of lower interest rates, which undoubtedly are on the way.

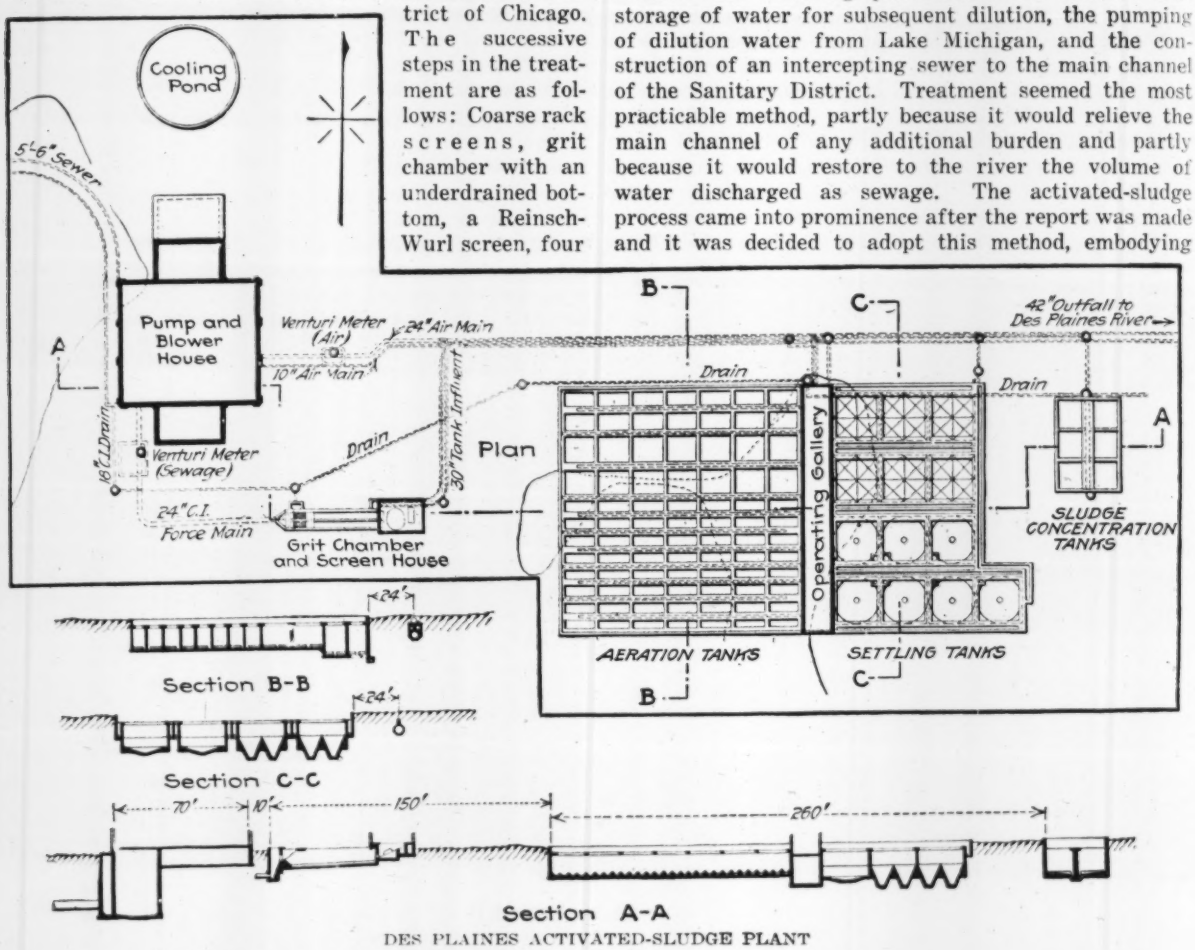
The manner in which the country has borne the great shrinkage in values, the comparatively few important failures, has shown that the business structure is essentially sound. The banks have carried the situation through the credit strain. There will be plenty of credit for a revival of business on a lower level of prices. The business organization is in working order and ready to resume normal operations when conditions are right, which, as we have indicated, will be when retail prices, wages and industrial costs generally have come down to the level reached by the basic raw products.

The Des Plaines River Activated-Sludge Plant

Chicago Sanitary District Is Building Model Plant With Wide Flexibility for Experiments on Moot Questions

By Langdon Pearse
Sanitary Engineer, Sanitary District of Chicago

An activated-sludge plant to treat the sewage of a number of villages on the Des Plaines River and thus prevent the present pollution of the water is being built at Riverside, Ill., by the Sanitary District of Chicago. The successive steps in the treatment are as follows: Coarse rack screens, grit chamber with an underdrained bottom, a Reinsch-Wurl screen, four aëration tanks and settling tanks, some of them fitted with Dorr thickeners. Although located in the country, special provision is made to filter the air supply for activation so as to reduce to a minimum the clogging of the filtros plates. Sludge is to be stored in a battery of six 18,700-gal. concrete tanks. Two types of filter press, the Berrigan or platen press and the plate press, probably will be installed, as well as a centrifugal of the ter-Meer type, together with a direct-indirect dryer which will burn Illinois coal screenings. It is the intention to make this a complete experimental plant and also a model plant with surroundings attractive as a park.



DES PLAINES ACTIVATED-SLUDGE PLANT

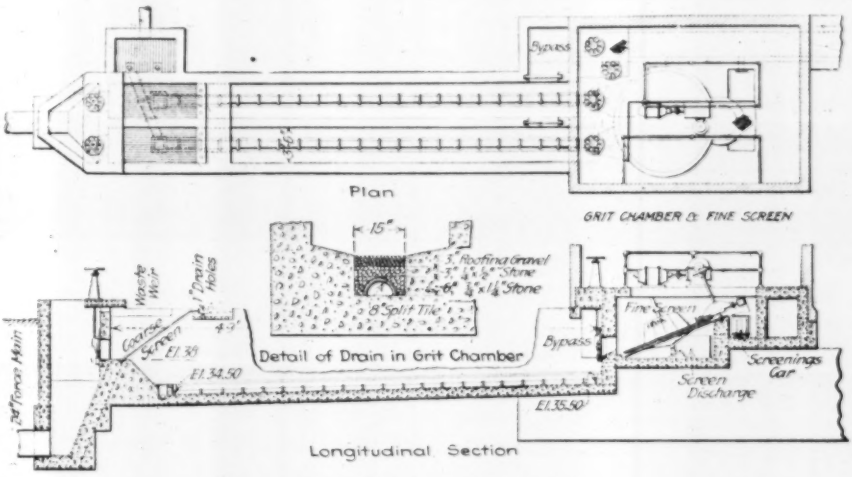
For many years the Des Plaines River at Riverside has annoyed residents within a mile of its banks. The major pollution comes from Melrose Park, River Forest, Forest Park and Maywood, with an estimated aggregate population of more than 30,000. The sewage is discharged at points four to five miles above the River side dam. Salt Creek, carrying the sewage of 16,200 people, also adds its burden to the river above Riverside. The pollution forms a sluggish flow or "piston" in the river, 10 to 15 days elapsing at times for the flow of five miles. Observations of the self-purification, as indicated by the dissolved oxygen, show that the piston moves up and down the river according to the flow.

After annexation of this territory to the Sanitary District in 1913, an exhaustive report, dated July, 1914, covered the following possibilities for relief: The storage of water for subsequent dilution, the pumping of dilution water from Lake Michigan, and the construction of an intercepting sewer to the main channel of the Sanitary District. Treatment seemed the most practicable method, partly because it would relieve the main channel of any additional burden and partly because it would restore to the river the volume of water discharged as sewage. The activated-sludge process came into prominence after the report was made and it was decided to adopt this method, embodying in it a number of experimental features to settle points of practice not yet determined upon. Construction started early in 1919 but progressed slowly owing to the strikes in the best working period of 1919 and to the hard winter following, but it is hoped to complete the work by the end of 1920.

The plant occupies a tract of 25 acres on the west bank of the Des Plaines River, 900 ft. south of Twelfth St., in open country near the Speedway Hospital, large cemeteries, an airplane field and the Riverside Golf Club. The sewage is collected from the various outlets of the villages by a 66-in. intercepting sewer, completed recently at a cost of $580,000. For the present flow, ranging from 4 to 10 sec.-ft. in dry weather, there are three 14-in. trash pumps with vertical shafts, working through a total lift of 32 ft., including friction.

ne discharge is through a 24-
in. cast-iron main and Venturi
eter to the grit chamber.
Space is left for two future
umps having capacities of 20
u.ft. per second.

To care for the fluctuation
in flow and to operate the
pumps continuously, particu-
larly on low flows, a by-pass is
provided from the discharge
of a small pump to the suction
well, with float control con-
nected to a hydraulic gate
valve. This arrangement will
automatically by-pass sufficient
sewage from the discharge
end to maintain a fairly uni-
form elevation in the suction
chamber.

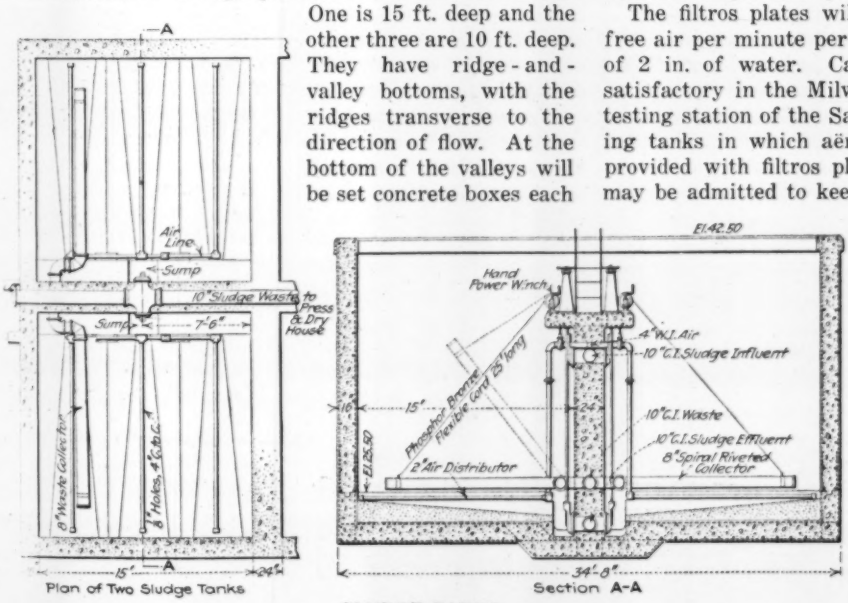


GRIT CHAMBER AND SCREENS

The pumps and blowers are arranged in one building, which also houses the air screens, transformers, switchboards, circulating pumps, heating plant and laboratory. The building has steel columns to support the roof trusses and the runway of a 10-ton hand-operated traveling crane. The walls are of brick and the roof is of gypsum tile covered with a weatherproof roofing. Current from the hydro-electric plant of the sanitary district at Lockport will enter the station at 12,000 volts and will be stepped down to 440 volts for the machinery and to 110 volts for lighting purposes.

The incoming sewage will be measured by a Venturi meter and discharged into the grit chamber through a coarse rack screen of bars of $\frac{3}{8}$ x $3\frac{1}{2}$-in. section with 1-in. space in the clear. The grit chamber has two compartments, each 3.5 ft. wide by 3 ft. deep by 47 ft. long. Velocities will be controlled by sluice gates at the outlet end. Following the grit chamber will be a Riensch-Wurl screen, 14 ft. in diameter, inclined 15 deg. with the horizontal. It will have $\frac{1}{16}$ x 2-in. slots. A by-pass around the screen is provided.

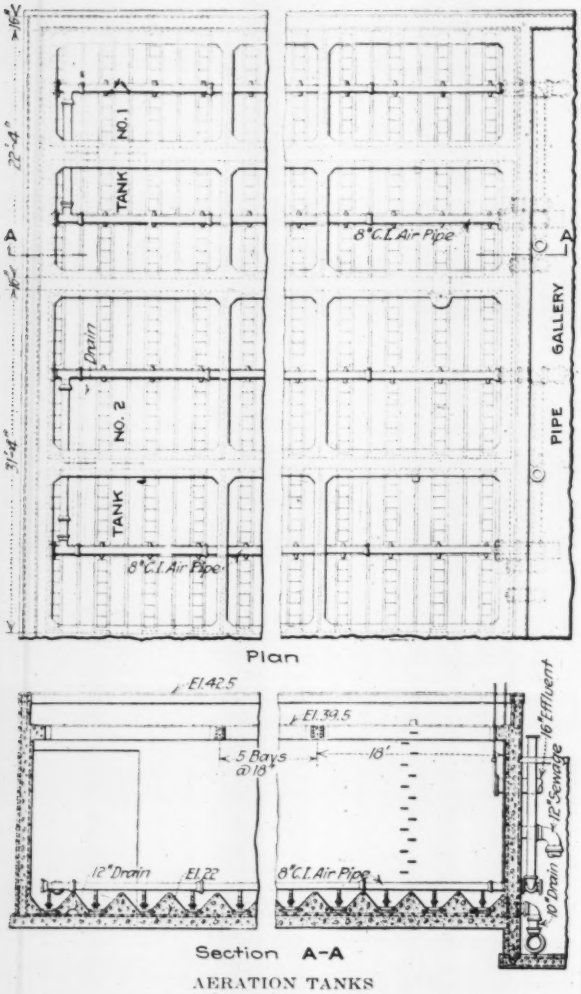
The screened sewage passes to the aëration tanks. One is 15 ft. deep and the other three are 10 ft. deep. They have ridge-and-valley bottoms, with the ridges transverse to the direction of flow. At the bottom of the valleys will be set concrete boxes each containing four or five filtros plates. The ratio of filtros plate to tank area varies from 1 to 5.7 to 1 to 5.9.



SLUDGE TANKS

Aëration Tanks—The aëration tanks are arranged to compare various methods of operation. One 15 ft. and one 10 ft. deep will be run as straight-flow tanks. One 10 ft. deep will treat sludge re-aërated during its return. Another 10 ft. deep will be run with sludge reaërated during its return and resettled before introduction into the incoming sewage. All aëration tanks are 126 ft. long inside. Of those of the straight-flow type, the 15-ft. tank has a net width of 21 ft. and the 10-ft. tank, 30 ft. 4 in. Both tanks are baffled once longitudinally so that the total distance of travel is approximately 250 ft. The two units in which aëration of sewage and re-aëration of sludge will be attempted are divided by baffles into four longitudinal channels, each 7 ft. 7 in. wide, the sewage and sludge aëration compartments being separated by a removable transverse baffle of wood so that the relative detention periods may be changed. These tanks may be readily converted into the straight-flow type if this method of operation proves desirable.

The filtros plates will pass from 10 to 14 cu.ft. of free air per minute per square foot with a loss of head of 2 in. of water. Cast concrete boxes have proved satisfactory in the Milwaukee tests and at the tannery testing station of the Sanitary District. Channels feeding tanks in which aërated liquor will be settled are provided with filtros plates in the bottom so that air may be admitted to keep the sludge in suspension. To provide the greatest flexibility, each aëration tank is equipped with three unit settling tanks each 24 ft. square. One additional settling unit is also provided for re-settling the sludge in connection with the re-aëration and re-settling operation. Various methods of settling will be compared, since one-half of the tanks have hopper bottoms with four pyramidal hoppers to each unit with a slope of 2 vertical to 1 horizontal and the other half has a circular bottom with a



AERATION TANKS

slope of 2 vertical to 12 horizontal. The latter are to be equipped with Dorr thickeners, a squegee cleaning device, which slowly collects the sludge to the center of the tank. An air-lift will raise the sludge to a measuring box, whence it will return either to the incoming sewage or to the re-aërating tank. Air-lifts are provided in each hopper of the pyramidal-bottom settling tanks to lift the sludge to measuring boxes that feed troughs of high velocity, which deliver the sludge to the re-aëration channel or to the return sludge channel. Aërated liquor will enter the settling tanks on two opposite sides through baffled openings. The settled effluent will flow over the effluent weirs forming the sides of troughs across the tank. The settled effluent passes to a 42-in. concrete outfall sewer extending 1,600 ft. to the Des Plaines River. At the upper end of the outfall is a connection to the overflow at the grit chamber and screen, so that the plant can be by-passed if necessary.

Blowers—The main pump and blower room is 60 × 70 ft. in plan. The pumps are located in the west end, and in the easterly portion are the motor-driven hydro-turbine blowers, with a total capacity of 11,500 cu.ft. of free air per minute. On recent tests of the blowers manufactured for the Sanitary District the following results were obtained.

Capacity Free Air, Cu.Ft. per Min.	Pressure, Lb. per Sq.In.	Brake Horsepower
427	6.81	22.6
1,020	6.41	59.3
1,685	6.57	108.6
2,730	6.69	133.4
2,400	8.53	133.5

The incoming air will be screened through duck supported on wooden slats in a large room on the south side of the building, 2,870 sq.ft. of area being provided, or roughly 0.25 sq.ft. for each cubic foot of air per minute. The air will then pass into a large concrete supply duct extending around the blower-room basement. The compressed air passes through separators to remove the moisture, and through check valves into the main header, thence through a Venturi meter to the aëration tanks. The check valves will have aluminum disks to reduce the loss of pressure through them.

Because of the high cost of cooling water, a set of centrifugal pumps is provided, with a cooling pond and spray, so that the water can be re-used.

Owing to the use of two depths in the aëration tanks two air lines are planned from the blower house, the larger, a 24-in., carrying air at approximately 6 lb. pressure; the other, a 10-in., carrying air at approximately 8.5 lb. pressure. There is a cross connection with a reducing valve in the blower house so that an excess of high-pressure air can be put into the low-pressure line. Inside the blower house, spiral-riveted steel pipe will be used for the air lines. Outside pipes are of cast-iron.

For convenience in manipulation, an operating gallery covered with a concrete walk has been established between the aëration and the settling tanks. In this gallery are housed the Venturi meters for measuring the flow to each tank of screened sewage and of air, the devices for measuring the returned sludge and the operating stands for the gate valves on air, incoming and outgoing sewage, sludge removal and drains. The meters on sewage and air will be provided with recording devices. However, the meters on the auxiliary air lines for air-lifts will only have manometers.

Sludge Handling—For the storage of excess sludge, sludge concentration or acidification prior to dewatering, a battery of six concrete tanks is provided. Each tank is 11.5 ft. deep and 15 ft. square. An adjustable outlet pipe will remove the supernatent liquor which separates from the sludge.

The sludge will be handled in a press and dry house, in which the liquid sludge, removed from the system direct or from the storage tanks, will be dewatered.

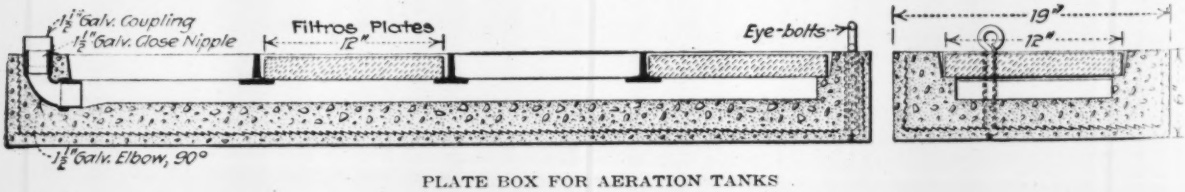
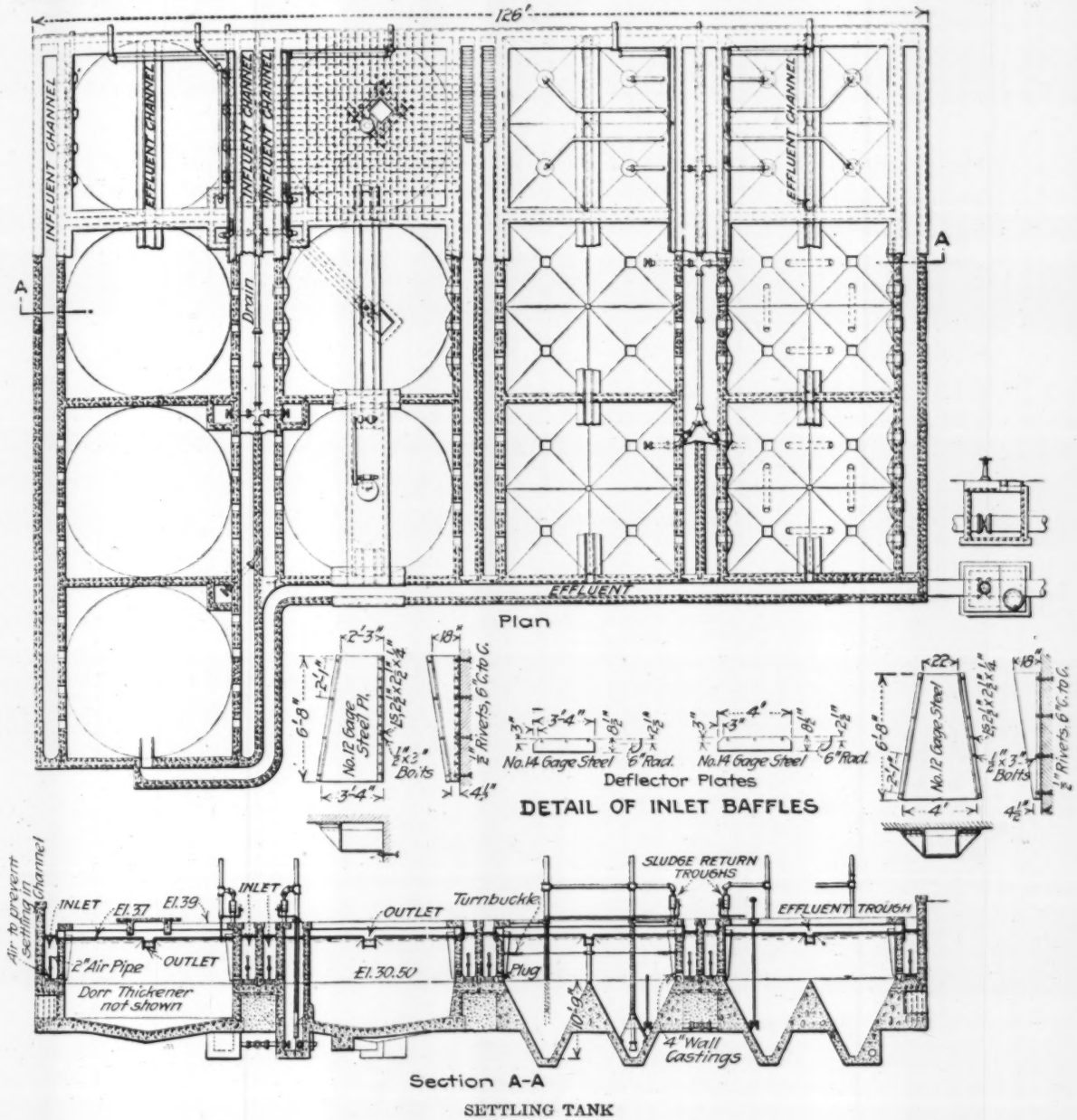


PLATE BOX FOR AERATION TANKS



SETTLING TANK

The water content of the sludge probably will be from 98 to 99.5 per cent of water. This will be reduced by filter pressing. The sludge cake from the press will be dropped into pans on wheels, rolled to a corner of the building and lifted to the second floor for storage and feed to the dryer. A centrifugal machine of the most recent ter-Meer type is also to be installed. This works continuously and discharges the cake automatically.

For drying the press cake, a direct-indirect dryer was selected after much investigation as the most likely to dry sludge without burning or scorching or causing the loss of nitrogen. A cyclone will retain the dust from the waste gases. The screenings from the Riensch-Wurl screen can be dried in the dryer, if suitable, and mixed with the sludge. Otherwise they may be burned or buried. About 3,300 lb. of dry sludge are expected per 24 hours, and about one ton of coal per day will be burned. Storage facilities as well as a screen and crusher for the dried sludge will be provided.

In the design of the plant advantage has been taken of the experience at Houston and at Milwaukee. Thanks are due to Messrs. Sands and Fugate and in particular to T. Chalkley Hatton for courtesies extended. Every effort has been made to prevent rust production, in order to reduce the likelihood of choking the filtros plates. Surfaces of all cast-iron or wrought-iron pipe have been coated. Traps are provided to remove all accumulated moisture and the inlet to the filtros boxes is trapped so that only a short length of galvanized wrought-iron pipe is directly tributary to it. Considerable care has been taken to make air lines drain and to provide blow-offs. A comparison is to be made on the durability and rusting qualities of dipped and galvanized cast-iron pipe, used in the air headers in the aëration tanks. Located in the outskirts of the

city beyond the industrial district, in the midst of farms, golf clubs and cemeteries, it is hoped that clean air can be secured by the cloth screens and the hydro-turbine blower.

A laboratory on the second floor of the pump and blower house will contain the necessary apparatus for the essential determinations to control the plant and to learn what is happening. Measuring devices have been provided wherever helpful quantitative data can be secured.

The operation of the plant will be continuous, except at times of high water, when the incercepting sewer will be submerged. The pumping of sewage will then probably be discontinued and air blown simply to keep the sludge alive. This condition will occur when the river stage reaches El. 35, Chicago city datum, or 5 ft. below the maximum flood heights. Space has been provided for a plant of equivalent capacity which may be operated with the present installation.

Until his resignation in May, 1920, this work was carried on under the general direction of George M. Wisner, chief engineer of the Sanitary District of Chicago. E. J. Kelly, formerly assistant chief engineer, was made chief engineer when Mr. Wisner retired. The engineering staff working on the plant includes the writer, as sanitary engineer; George S. Brack, electrical engineer; C. R. Dart, bridge engineer; H. I. Steffa, mechanical engineer, and F. L. Barrett, architect. R. H. Burke, division engineer, is in charge of the construction of the intercepting sewer, pumping station and treatment plant. L. C. Whittemore, assistant sanitary engineer, has been in charge of the preparation of the contract plans for the treatment plant under the direction of the writer. A. B. Wood, New Orleans, was consulting engineer on the pumps and pump layout. The Leyden-Ortseifen Co. is the principal contractor but the contracts have been let to various trades in considerable detail, thereby securing vigorous competition.

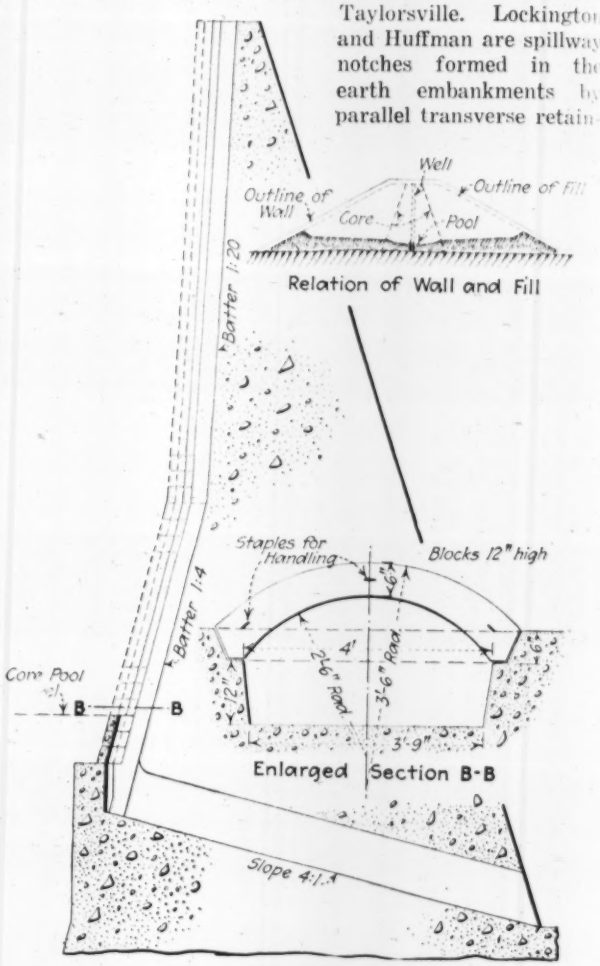
Water-Supply Improvements at Cleveland

The general program for water-supply improvements at Cleveland, Ohio, outlined in *Engineering News-Record*, Nov. 4, p. 886, in connection with the article by A. V. Ruggles, engineer of construction and surveys, Division of Water, is now being carried out. According to a letter from Mr. Ruggles excavation is in progress for the proposed Baldwin filtration plant with a capacity of 165,000,000 gal. a day and designs are being made for the plant and for the lining and covering of the Baldwin reservoir; the excavation for the latter having been finished. Plans are also being made for the reconstruction of the Fairmount pumping station and for various pipe lines or force mains from this station. It is expected that the contracts will be let in the spring for a 48-in. main connecting the Baldwin plant with the new East station to be built later on in the eastern end of the city. In accordance with the recommendation of the commission that reviewed the water-supply report abstracted by Mr. Ruggles in the article already mentioned, water rates in Cleveland were raised on Oct. 1 from 40c. to 60c. per 1,000 cu.ft. It is expected that the new rates will make it possible not only to pay interest and sinking fund charges on the cost of the improvements now being put under way, but also provide sufficient money, within ten years, to pay off a large bonded debt which has been refunded again and again.

Core-Pool Overflow Forms Core Inspection Well

TO PROVIDE overflows for the core pools in constructing three of the hydraulic fill dams for the Miami valley flood protection works, and also to provide a means for inspecting the process of core consolidation, wells designed as shown by the drawing are provided in the outlet works retaining walls.

As described in *Engineering News-Record*, June 10, 1920, p. 1143, the outlet structures of the dams at Taylorsville. Lockington and Huffman are spillway notches formed in the earth embankments by parallel transverse retaining walls. The ends of the embankments butt against the backs of these walls, which have a coping profile corresponding to the embankment slopes. The overflow and inspection wells, as indicated by the sketch inserted in the drawing, are located about on line with the vertical axes of the embankment cores.



WELL IN OUTLET WALL FOR CORE POOL OVERFLOW

In hydraulic filling the embankment the segmental blocks are laid up with each lift of the core pool and form the weir for the pool outlet. Every third block has a radial hole through it at the center of the arc. Plugs of wood close these holes, but when removed, at any time after the core has been raised above them, the holes are open for noting how the core has hardened and what its character is. Other methods of investigating the behavior of the core fill at the Miami Conservancy District dams were described in *Engineering*

News-Record, Dec. 25, 1919, p. 1040. Construction is under the direction of Arthur E. Morgan, chief engineer, Chas. H. Paul, assistant chief engineer, and C. H. Locher, construction manager.

Timbers of Tropical America and Railway Tie Supply

Hardwoods of Central and South America Little Known—Some Varieties Described—Life of Ties in Cuba

By Albert W. Buel,
Consulting Engineer, New York City

EAST timber resources exist in tropical America. Both the abundance of the supply and the remarkable quality of many of the woods make these resources of great importance for the future if not, indeed, for the present status of our timber supply for construction and industrial use. Hitherto practically all attempts to import timber or lumber from the countries to the south of us have been unsuccessful and unsatisfactory, except in so far as they relate to fancy and special woods, as those for the furniture and dye industries, involving values three to five times those of our native woods. In particular, attempts to develop a railway tie supply from the tropical and semi-tropical forests have failed. Yet there is good reason to believe that in this very field is to be found one of the most immediate and most significant possibilities in the use of tropical hardwoods.

In a special report of the committee on ties of the American Railway Engineering Association, made some months ago at the request of the Railroad Administration, the unsatisfactory condition of our tie supply and its probable future was fully discussed. At the present rate of consumption, the report says, the standing timber in the United States would be exhausted in thirty years, but due to increasing value and similar causes affecting consumption the present supply supplemented by new growths will last at least fifty years. During this period, however, the cost of ties will increase continually, quality will decrease, and more and more difficulty will be experienced in supplying the demand. For these reasons the development of additional sources of supply is of prime importance.

Why Previous Enterprises Failed

It is not hard to find reasons for the failure of previous attempts to organize a commercial supply of lumber, structural timber or ties from tropical forests. In all the cases known to the writer one or more of the following conditions brought the enterprise to failure:

1. Until the present time the market prices of domestic woods were so low that the products of tropical forests could not be sold here at a profit, or at least not at a margin commensurate with the risks and difficulties of the undertaking. This is now changed, according to the statements of men intimately acquainted with the market. The conclusion is well warranted that under existing conditions such enterprises, if handled with judgment and managed efficiently, offer excellent prospects of success. This conclusion applies to many, if not all, of the possible sources of timber supply from central and tropical South America.

2. Little is known in the United States about the various species of tropical woods available. Their qualities, in the way of durability and suitability for particular uses, have received practically no attention on the part of American timber users. Repeatedly timber cut from species of trees entirely unsuited to the use intended has been imported, with the result of creating an erroneous impression that tropical woods are quite unsuited to our requirements.

The difficulty arising from our lack of knowledge of the qualities of the woods is increased by the fact that tropical forests consist of mixed stands, with as many as twenty or thirty species grouped together. Further, the species are known by local names only, and the same species often have different local names in places only a few hundred miles apart. Sometimes, indeed, the same name is given to woods of different species in contiguous forest regions. No comprehensive botanical surveys have been made in any of the countries in question, so far as can be ascertained. These conditions quite obviously introduce confusion into the subject of tropical timber supply. Nothing would more effectively tend to conserve our North American forests by bringing the tropical and semi-tropical forests into the position of supplementary supply than a botanical survey of the standing timber of tropical America north of the equator. It would be desirable if means could be found to carry out such a survey at the earliest possible date. Such organizations as the Forest Service, the Smithsonian Institution, the American Museum of Natural History, should find this undertaking well within their abilities and their field of interest.

3. Most lumbering operations in tropical countries have been undertaken by inexperienced men, and these men have failed to employ capable advisers and managers. Under these circumstances insufficient consideration was given to the difficulties of the undertaking and adequate capital was not provided. Failure was but natural under such conditions.

Important Caribbean Woods

A noteworthy contribution to the subject of developing the Central American timber resources was made by T. W. Braddy, in charge of the lumber industry of the Panama Canal, in a paper presented before the Engineers' Club of the Canal Zone about a year ago. Mr. Braddy listed and described the principal Panaman woods, and discussed their availability for use in the United States. Engineers will be partciularly interested to know that the first four woods he mentions are of demonstrated high value for structural purposes and are among the strongest and most durable woods known, while seven or eight other species of his list are being used extensively for building construction, as interior trim and in cabinet work. Using his data, the following summarized account of the most important woods of the Isthmus (and in fact of the Caribbean region as a whole) has been prepared. The woods are listed in the order of their relative weight and strength.

Guayacan—The yellow guayacan grows 50 in. in diameter and 100 to 150 ft. high. It furnishes one of the hardest, densest and most durable woods known. It is of the same genus as lignum vitae *(Guaiacum Zygophyllaceae)*.

Almendra—No timber has given more satisfaction in ship and dredge work than almendra. It is similar in color to yellow guayacan, but occurs more abundantly. It grows up to 60 in. in diameter and 140 ft. high, but sometimes the trees branch as low as 30 ft. from the

ground. The wood is stronger, heavier and much more durable than white oak.

Alcareto—Alcareto has proved the most widely useful timber in Panama as a general substitute for oak, in work not requiring as heavy and strong a wood as guayacan and almendra. The tree grows to a height of 120 to 140 ft., without showing a branch. When green the wood is of a deep purple, the color changing to a light brown in seasoning. Alcareto does not check, has about the same weight and hardness as oak, and is more durable. It occurs abundantly, but the trees rarely attain a diameter as large as 30 or 36 inches.

Amargo—The lightest of the hardwoods used (except roble) is amargo, a wood of deep golden yellow color containing a resinous substance. It does not check and is a good substitute for oak, ash and maple. It is believed to be more lasting than alcareto, though lighter and less strong. The tree grows to 65 in. diameter and 150 ft. high, and is of symmetrical form and uniformly tapered, so that it is excellent from the lumbering standpoint.

Four woods of similar appearance but of very different botanical nature, *Batteo Marie*, *Caobo blanca*, and *Cedro amargo*, are being used for flooring, siding, interior trim and cabinet work, but have not been tried in structural work. Other trees available for interior trim that deserve mention are *Cedro espinosa*, *Coratu*, and *Espeve*. These woods are quite dissimilar in appearance. The trees are abundant and have a fair timber form.

Alcavu is a soft but long-lived wood and makes beautiful lumber. *Nispero* is a very hard wood, and incidentally yields a high grade rubber called "Balateo" and bears a very fine fruit. The wood season-checks very badly, however, and is useless for lumber or structural purposes unless means can be found to prevent its checking.

Among other Panama species some of which may be available for lumber or structual timber are *Mora*, *Mangle blanca*, *Mangle colorada*, *Soro*, *Quira*, *Amorilla*, *Marmocillo*, *Roble*, *Pilon*, *Tangari*, *Nogalon*, and others. They are, however, by no means of an importance commensurate with that of the woods mentioned before, and not much is known about their physical properties.

Points on Tropical Lumbering and Milling

As the governing factors of logging, milling and marketing in the tropical and semi-tropical countries differ materially from those in the United States special study must be given to the peculiar difficulties of the undertaking if success is to be assured and the necessary development capital attracted. Mr. Braddy in his discussion of the subject reviewed some of the points requiring attention. As he stated—and the writer is able to confirm this—little difficulty will be experienced from insufficient supply or excessive cost of labor. The difficulties center largely in providing a supply of logs to the mill, organizing the operating system of the mill, and organizing the marketing system with due regard to the variety of woods to be handled. Further, very careful technical study must be given to the problem of seasoning and kiln drying.

Discussing logging operations, Mr. Braddy suggests that modern logging machinery, properly applied to the local conditions, will prove entirely adequate to deal with the work. The ground skidder, the trolley skidder and the derrick barge have been supplemented with great success by the caterpillar tank, which has proved capable of bringing out timber from lands hitherto considered inaccessible to transportation.

Logging railroads will, however, prove an indispensable device in most of the tropical timber regions. In some instances these exploitation lines will require large investments of capital and the application of a high degree of engineering skill. A number of projects of this character have been studied by the writer and he feels on very certain ground in emphasizing the importance of considering transportation questions in addition to the problem of logging in the woods. Accessibility of supply is of prime importance, especially in the early years of such an enterprise.

Seasoning and Kiln-Drying

Reference to the formidable difficulties presented by the checking of some of the tropical woods should be sufficient to direct attention to the seasoning and kiln drying part of tropical lumbering. Cases have indeed occurred in which a promising enterprise to supply lumber from South or Central America to United States ports has been wrecked by disregard of the disastrous effects of checking. Logs, tie timber and finished lumber are all concerned in the seasoning problem. Both kiln drying and yard seasoning, therefore, must be studied, organized and administered with unusual care, not merely to reduce the losses of material, but, what in these enterprises will prove to be the critical consideration, to assure the supply to the purchaser of a satisfactory material, and thereby retain the confidence and good will of the market.

Organizing the mill operating system is intimately related to the character and size of enterprise suited to the South and Central American conditions. On this a paragraph from Mr. Braddy's paper is pertinent:

"Central America is not believed to be a country well suited to small mills scattered here and there over the land, for the small mill is usually backed by small capital and it is hardly possible with a small outlay of money to operate and maintain a logging equipment that it would require to stock even a small mill with logs for any length of time. Because the timber never occurs in pure stands a mill must engage in the manufacture of miscellaneous woods. This raises the most difficult feature of sawmilling to be met with, for it is necessary to make at least three grades of lumber from each species of timber handled. The Balboa plant is handling eight different kinds of timber; in the No. 3 grade all third-class material is placed regardless of species, while No. 1 and No. 2 are classified according to the species, thus making seventeen classifications. Assuming that a modern mill were operating here cutting from 40,000 to 60,000 ft. of bill stock per day and 20,000 ft. of boards, to say nothing of the miscuts, shorts and other scrap that would accumulate and could be worked up in slack and tight cooperage stock, crate stock and basket material, it would be necessary to handle at least twelve different kinds of timber, and at least five grades of each species, thus requiring skid room, storage space and marketing facilities organized on a large scale."

An American engineer who during the past twenty years has spent considerable time in construction work in half a dozen of the countries bordering on the Caribbean Sea has made available to the writer some of the data which he has systematically collected on the subject of the semi-tropical hardwoods. These data,

together with perhaps equally extensive data collected by the writer through correspondence, interviews and information obtained in personal experience have been drawn upon for a table of the life of Cuban hardwood railroad cross-ties, representing actual service data. The figures of long life obtained are likely to prove surprising to railroad men of the United States, who deal with very much shorter periods of life even in the case of their best tie materials.

In connection with the general data on woods it should be said that particular attention has been given to securing data on the tendency of different woods to check, and on whether the checking is radial or tangential. The information on this point is necessarily rather incomplete and not altogether satisfactory. So far as it has been used in the table, however, it may be relied upon.

Briefly, stating the net showing of the table in a single conclusion, it may be asserted that, properly

LIFE OF CUBAN HARDWOOD TIES

Name of Timber (Botanical Name)	Life in Years Reported by — Cuban Central Ry.	Cuba R.R.	United Railways of H.	Esperanza Plantation Rys.	Ponupo Manganese Co. Rys.	Average
Caguairan †† (*Copaifera Hymenaefolia*)	30–40	25	* *	30–40	20+	28
Yabat (*Andira Inermis*)	.....	..	*	35	....	25
Majagua de Costat	.....	25	...	.....	10	17
Guayacan Blancot (*Guaiacum Oficinale Zigophyllaceae*)	..	..	* *	.....	20	20+
Iiquí††† (*Romelia Horrida*)	20–30	25	* *	20–30	....	25
Iocuma††† (*Sideroxiten Saticifolio*)	20–30	..	*	20–30	....	20
Chicharron†† (*Terminalia Chicharronia*)	30–40	..	* *	30–40	....	27
Moruro†† (*Pithecobium Filicifolium*)	.....	25	*	10–14	....	17
Sabicú†† (*Mimosa Odoratissima*)	.....	..	*	10–14	8	14
Júcaro Negro††† (*Terminalia Augustifolia*)	.....	25	*	10–14	10	15
Acana††† (*Bascia Albercens*)	.....	25	*	10–14	10	15
Jaimiqui (*Mimusops Jaimiqui*)	.....	..	*	.....	....	15

Average Life, in last column, is estimated from all available data, including experience of Cuban engineers in government service and independent practice.

*Most commonly used in Havana, (average life on dirt roadbed without ballast of any kind and very poor drainage, 10-12 years.

** Used, but not so easily obtained, average life on dirt roadbed without ballast of any kind and very poor drainage, 10-12 years.

† Does not check.

†† Seldom checks, or checks very little.

††† Checks badly or often.

selected, tropical hardwoods will prove gratifyingly serviceable and durable. Timber cannot be exported from Cuba at the present time in commercial quantities. But the timbers of the entire Caribbean region are closely related, and the species represented in the table as well as others are found also in the other Central American countries; and almost the same remark might be made concerning South America.

The Panama R.R. specified as acceptable for railway ties (in addition to guayacan), alcareto, amargo, almendra and nispero. On account of its tendency to check, it is doubtful whether nispero would be satisfactory in northern climates.

In Venezuela, ties of vera *(Guaiacum arborium)* and curarire *(Tacoma chrysantha)* last 25 to 30 years, and fail only by mechanical abrasion.

The greenheart of British Guiana *(Nectandra Rodioei lauraceae)* is rated first class by Lloyd's, as is also Mora *(Dimorphandra mora caesalpineae leguminoceae)*, which is probably closely related to if not identical with the Cuban caguiran. These are two of the best tie and structural timbers, ranking with the guayacans.

It remains to identify species found in greater abundance in other and more accessible localities and now known only by various local names, with the six or seven best Cuban species, the four from Panama, and two each from Venezuela and British Guiana, as to which service records extending back 30 to 50 years are available. This work should be near the top of a botanical survey program.

There are several species each of the Guaiacum and Tacoma families that are said to have nearly equal value as tie timber, and it is probable that many if not the larger number of copaifera trees will prove serviceable. It is, however, important to bear in mind that 60 to 80 per cent of the stand in any subtropical forest is composed of species entirely unsuited to use as railway cross-ties, and, further, that some species which give fair service in their native climate may fail in northern regions, due to their tendency to develop radial season-checks extending from face to center of heart.

The opportunities for developing a satisfactory supply of ties to supplement our rapidly diminishing North American stock of tie timber therefore appear bright. If they are grasped, the time when wooden ties must pass out of use may be postponed indefinitely.

Prospects for Railway Tie Supply From South America

Tropical Timbers Now Offered — Little Knowledge of Behavior in United States — Indefinite Classification of Species

ALTHOUGH vast timber resources exist in the tropical forests of Central America and South America, there are technical and commercial difficulties attending the use of these timbers to supplement the supply of ties for railways in the United States, according to a recent paper by H. von Schrenk, consulting engineer, St. Louis, Mo. During the past thirty years there have been occasional shipments of ties from tropical countries but there is no adequate record of their species or service. Practically, however, this field has not been touched, but it is being given renewed attention and numerous offers are being made of various kinds of wood. The following notes are taken from the paper mentioned above.

Mexico has a large forest area, including both mountain and tropical regions. The mountain forests are composed largely of pines and are more or less inaccessible. The tropical forests contain a variety of hardwoods, there being, for example, some 85 species of oak in the territory tributary to Vera Cruz. In Central America there are large supplies of hardwood on the Pacific side, while the Gulf side has extensive pine forests, many of which are easily accessible. The chief tropical resources, however, are in South America, the largest area being in Brazil. Several years ago some ties imported from the Amazon region were laid on eastern railways, all of these being extremely hard and bearing no resemblance to woods found in the

United States. The Guianas are rich in forest resources and it is here that the valuable greenheart and mora are found. Venezuela and Colombia have smaller forests but can be counted upon for a large future supply. The mountainous parts of Chile and Peru are forested, but these countries at present import most of their timber from the United States.

Although these vast resources exist, Mr. von Schrenk points out that they are not available at this time and much development work will be necessary before they can furnish commercial supplies. Tropical timbers (with the exception of the mountain pines) grow in dense jungles and usually a large number of species grow close together. Thus if ties of lignum vitæ only were required they would have to be obtained from trees widely separated, while in any one acre where such a tree was found there would be 50 or 60 other species. For this reason, in order to make the cutting of ties commercially practicable it would be necessary to take a large number of different kinds.

In this connection, Mr. von Schrenk points out that the fitness of tropical woods for use as ties has yet to be determined. Hardwoods which have given excellent service in their native lands have failed when used as ties in the northern temperate regions, mainly by splitting and checking under the influence of the wide extremes of temperature to which they are subjected. Without further experience it would be risky to purchase any large number of ties of a particular species. During the past thirty years a number of species have been imported, but owing to incomplete records as to their names, origin and years of service it is in most cases impossible to determine their value as tie timbers.

Another difficulty is indefiniteness as to the nomenclature or classification of different species. Thus, samples submitted under various oak names have been found not even related to the oak family. A purchaser, therefore, must be careful to assure himself that the tropical wood offered has not only the local name by which it is known, but has also the botanical name by which alone it will be possible to specifically identify future shipments. Mr. von Schrenk is emphatic in stating that too much stress cannot be laid upon the absolute necessity of proper identification. Where tropical sources of tie supply are under consideration every possible care should be taken to have the proper botanical and other identification of all trees from which the ties are to be made.

Irrigation and Navigation Conflict

Interference with navigation in the Sacramento River caused by the diversion of water for irrigation is outlined by Lieut. Col. W. Kelly, Corps of Engineers, U. S. A., San Francisco, in a circular letter. The importance of irrigation, he says, is appreciated so fully that his office has been directing its activities "toward finding a solution that will permit maximum diversion and at the same time give permanent, reliable, all-year navigation." This will require movable dams with locks. A tentative plan for four dams has been made, but as the cost is beyond what Congress is likely to be willing to appropriate, Colonel Kelly has sent out the circular letter already mentioned to the irrigation interests to ascertain whether they would share with the government the expense of the dams.

Improve Small Water Power by Building Eight Dams

Primitive Construction Provides Storage for Modern Development in Nipissing Region of Northern Ontario

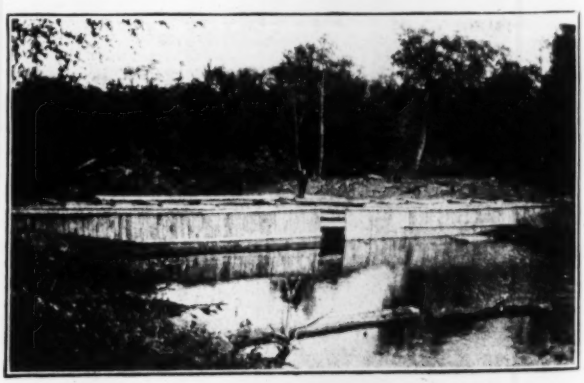
ON account of the growing demands in the town of North Bay, in the Lake Nipissing region of Ontario, the Hydro-Electric Power Commission of Ontario is enlarging the capacity of the local electric power station, which has only recently been purchased from private interests. The most interesting feature of the revision is the construction of eight new small dams in

DOWNSTREAM FACE OF 12-FT. CRIB

the headwaters of the South River, which the plant utilizes, thus providing enough storage to dispense with the steam auxiliary which had been used when the river was low. The dams are in remote districts, where construction refinements would be expensive and so are being built in rather primitive fashion.

The old plant had a capacity of about 900 kw. with a low-water flow of only 75 sec.-ft. The steam auxiliary, therefore, was frequently called into service. The new plant will develop 1500 hp. continuous with a plant efficiency of 80 per cent, and on this basis 2200 hp. with an annual load factor of 70 per cent.

On the headwaters of the river are a series of small lakes now ranging in surface area from 100 to 1,000



UPSTREAM FACE OF SUPRISE LAKE DAM

acres each, the most remote being about 30 miles from the power house. The new dams are at the outlets of these lakes and increase their area and storage capacity. In all a total new storage of about 26,000 acre-feet will be created, heads at the dams varying from 2 to 14 ft. The dams themselves are of timber-crib, rockfill construction, sheeted on the face and puddled, with a single sluiceway containing stop logs, to permit

regulation of the outflow. They were built by local labor with such local material as could be obtained and with practically no machinery. The control will be in the hands of the Government park rangers who patrol this district.

In addition to providing additional storage the power house itself will be revamped, particularly to improve the rather antiquated turbines. New runners have been designed for the old casings which will develop 1400 bhp. each, in place of 1,000 bhp. developed by the old runners. New seal rings will be put in, and the connection between the guide vanes and the governor, which at present is very light, made more substantial. In addition to this, two new butterfly valves will be placed in the power house instead of the old gate valves, and sometime in the near future a new wood-stave pipe will be installed in place of the old one. New electrical equipment is also being installed, as well as a new shaft.

Concrete Towers at Railway Water Stations: C. & N. W. Ry.

Standard Design Adopted—Longer Life than Steel at Same Cost—Maintenance Cost Nominal —No Frost Box Required

RECTANGULAR TOWERS of reinforced-concrete to support elevated tanks at water stations, which are being introduced on the Chicago & Northwestern Ry., have about the same first cost as steel towers but have practically no subsequent expense for maintenance or painting. In the cost of a steel structure frost boxing around the pipes is included, but this is eliminated with the pipes enclosed in a concrete tower. The design for the concrete structure was made in 1918, on account of the shortage of steel resulting from war conditions, and it has been adopted as a standard design. Wood-stave tanks, 24 ft. in diameter and 16 ft. high, of 50,000 gal. capacity, are provided for in the typical design shown in the accompanying drawings, and several of these towers have been built. Larger towers are being designed for 77,000-gal. tanks 30 x 16 ft. In its essential features the monolithic structure consists of a tower 10 ft. square on a foundation slab 20 ft. square and carrying a circular top slab 23 ft. in diameter. In good ground the base is 6 ft. below rail level, but this depth is increased where necessary, the pipes being then supported at the normal level by concrete pedestals upon the floor. It will be seen that the top slab is formed with ribs or joists on which the tank bottom is placed, these taking the place of the wood joists ordinarily used and providing ample ventilation to prevent decay of the wood. Timber brackets, bolted to the wall of the tower, carry a frame supporting the hinged spout for supplying water to the locomotives. A concrete mix of 1:2:4 is used, made with stone not exceeding 1 in. in size. Exposed edges are beveled by 1 x 1-in. triangular strips placed in the forms. After 14 to 31 days, depending upon weather conditions, the forms are removed, the exposed interior and exterior surfaces being then rubbed down with emery bricks. Steel reinforcement consists of square deformed bars, with flat sheets of rib metal in the walls, the joints of bars being lapped and wrapped with wire. Frost-proof covering on the inlet and discharge pipes consists of two layers of tar paper, two layers of 1-in. hair felt and two layers of tar felt, each layer being wrapped spirally with wire. Over this is a canvas jacket which is given two coats of asphalt paint. A door and two windows are formed in the tower.

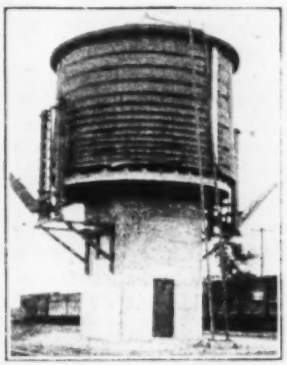


FIG. 1. WATER STATION WITH CONCRETE TOWER, CHICAGO & NORTHWESTERN RAILWAY

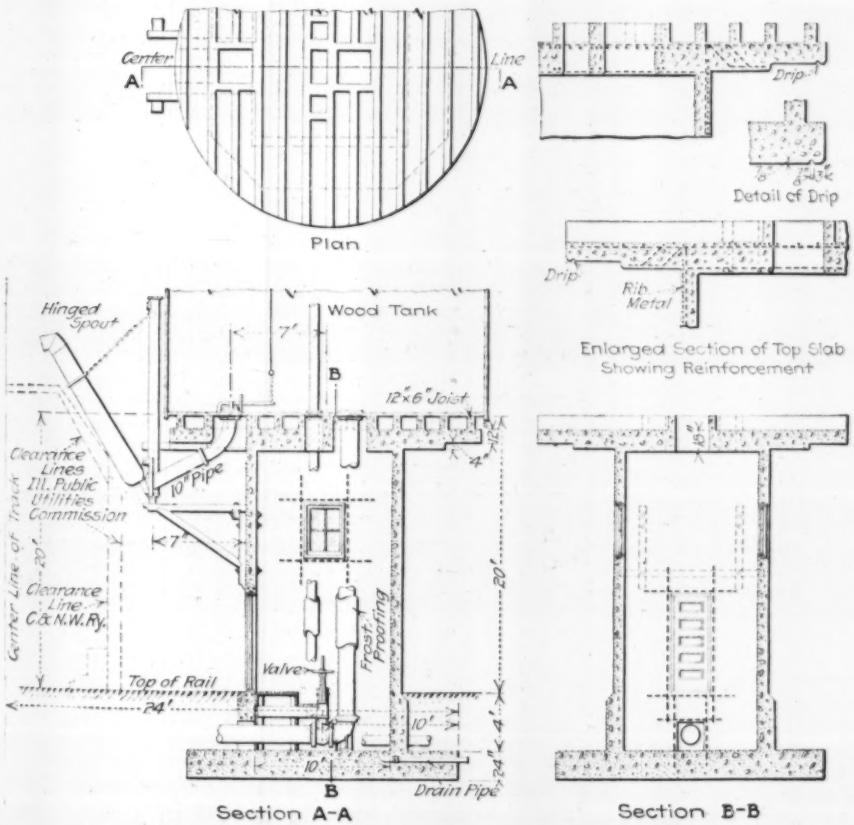


FIG. 2. DESIGN OF CONCRETE TOWER FOR WATER TANKS

Design Figures. — For the typical tower shown in the drawing the total assumed load on the base is 759,000 lb., including 429,000 lb. for tank filled with water, 316,500 lb. for 81 cu.yd. of concrete, 8,500 lb. of reinforcing steel and

5,000 lb. for piping. The soil pressure averages 1,900 lb. per square foot, with an allowable maximum of 2,300 lb. Wind pressure is taken at 25 lb. per square foot on the horizontal projection of the tank and 50 lb. on the tower. Unit stresses are 16,000 lb. for tension in steel, 750 lb. compression in concrete, 120 lb. shear in concrete reinforced with stirrups and 40 lb. where there is no shear reinforcement. The ratio of moduli of elasticity of steel and concrete is 15.

A life of about 70 to 80 years is expected for these concrete towers, as compared with an average of 35 to 40 years for steel towers and 18 to 20 years for framed timber towers, all under similar conditions of climate and service.

The concrete tower design was worked out under the direction of O. F. Dalstrom, engineer of bridges, Chicago & Northwestern Ry. Construction is done both by company forces and by contract.

Engineers' License Examinations in Different States

ABSTRACTS of the examination conditions in those states which require the licensing and registration of engineers for the practice of their profession, as published in the November "Proceedings" of the American Society of Engineers, are given herewith:

Colorado—Each candidate is examined in that branch of engineering in which he is proficient, as set forth in his application. The board conducts the examination in such manner as it deems best suited to determine the fitness of candidates, and it may summon any licensed engineer to assist in preparing for and in conducting examinations. Fee for examination, $10; for license certificate, $5, and for renewal certificate, $5 annually. Application is made to State Engineer, Secretary, State Board of Engineer Examiners, Denver, Col.

Florida — The board has ruled that examinations may consist of the applicant's sworn statement of professional education and experience in responsible charge of engineering work. If this statement is not complete or qualifying the board may summon the applicant to appear for further examination and may investigate his record of professional service. Examinations may be either oral or partly oral and partly written. Fee for examination, $15; for certificate of registration, $10 additional; for registration without examination, $25, and for renewal of certificate, $5 annually. Application is made to the Secretary, State Board of Engineering Examiners, 215 East Bay St., Jacksonville, Fla

Idaho—Examinations are held semi-annually in the State Capitol, Boise, Idaho, beginning at 9 a.m. the second Tuesday of March and September. Applications must be received ten days before the date of examination. Fee for residents, $10; for non-residents, $25; for renewal, $2 annually. Application for a certificate of registration is made to the Department of Law Enforcement, Boise, Idaho, under oath, in such form and accompanied by such proof of the applicant's fitness to practice as the department may prescribe. The application is made in writing accompanied by an unmounted photograph taken within a year.

Illinois—Structural engineers' examinations include written and oral tests and embrace subjects normally taught in schools of structural engineering. They occupy three days and cover theoretical and applied mechanics, definitions, general engineering knowledge, stress analysis, static and moving loads, design and construction in reinforced concrete, steel, wood, masonry and foundations. Fee for examination, $10; for certificate of registration, $5; for examination to determine prelimniary education, $5; for restoration of an expired certificate, $5; for renewal of certificate, $1 annually; for certificate to those who hold a like certificate from another state or country, $15. Application is made upon prescribed blanks to the Department of Registration and Education, Springfield, Ill. [Separate examinations by other boards are required for surveyors and for architects.—EDITOR.]

Iowa—Examinations are as prescribed by the board. Fee for examination, $15; for certificate of registration, $10 additional; for certificate without examination to person registered in another state, $10. Application is made to the State Board of Engineering Examiners, Box 923, Des Moines.

Louisiana — Examinations are required of all who are not graduates of an engineering college or school of good standing. Examination for surveying covers geometry, plane trigonometry, plane surveying and practical use of instruments. For engineering it covers also physics, including practical problems in design and construction. Fee for examination, $25; for registration by diploma, $25; for registration of holder of license from another state, $15; for issuing license certificate, $1; engineering renewal license, $3 annually; surveying renewal license, $1 annually. Application is made to the State Board of Engineering Examiners, Maison Blanche, Building Annex, New Orleans, La.

Michigan—Examinations are required of all who desire to begin the practice of architecture, engineering or surveying as principal or in responsible charge, except those from other states. These examinations include English language and other appropriate subjects. Fee for examination, $5; for certificate of registration, $15 additional; for certificate of registration without examination, $20; for renewal of certificate, $5 every five years. Application is made to the State Board of Examiners for the Registration of Architects, Engineers and Surveyors, 80 Griswold St., Detroit, Mich.

New York — Present practitioners must obtain licenses before May 14, 1922. If evidence presented in the application does not appear to the board to warrant a certificate the applicant may present further evidence, which may include the result of a required examination. Fee for certificate to practice engineering or land surveying, $25; for certificate to practice both engineering and land surveying, $35. Application must be made on a prescribed form to the Regents of the University of the State of New York, Albany, N. Y.

Oregon—Examinations may be either oral or partly oral and partly written. Fee for examinations, $10; for certificate of registration, $5 additional; for certificate of registration without examination, $15. Application is made to the Secretary, State Board of Engineering Examiners, Corbett Building, Portland, Ore.

Virginia — Examinations are required of all applicants except those from other states. They are held at least once each year at Richmond, Va., and at such other places and times as the board may designate. Fee for each examination, $20. Application is made to the State Board of Examination and Certification of Architects, Professional Engineers and Land Surveyors, Richmond, Va. Registration is optional. Present practitioners are not limited as to the time within which to register.

Wyoming—Examinations are required of all applicants except those licensed under previous acts, and consist of a written examination and an investigation of record, training and experience. Fee for examination, $10; for certificate of license without examination, $5. Application is made to the State Board of Examining Engineers, Cheyenne, Wyo.

Survey of Tennessee River Basin

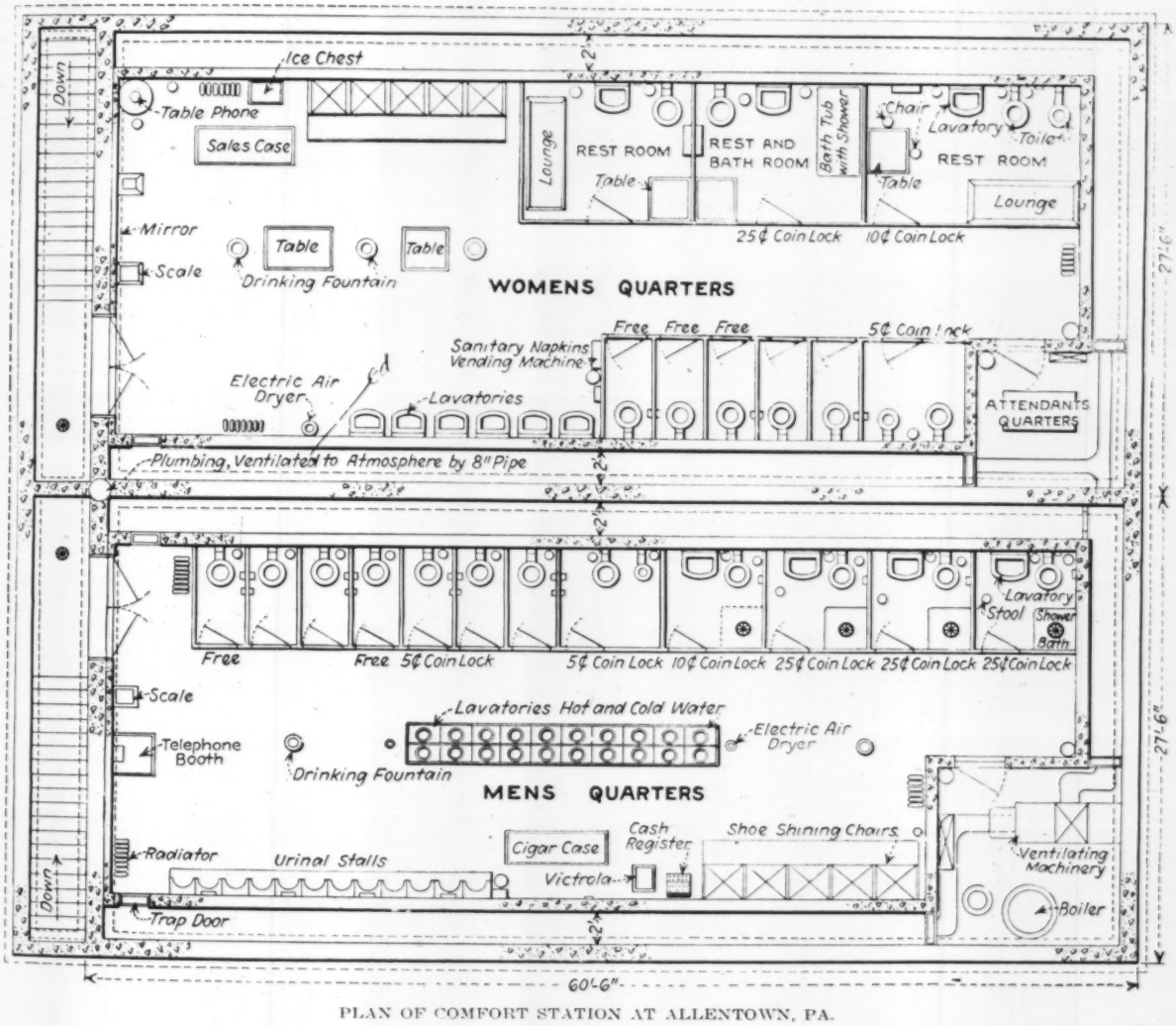
The United States, in co-operation with the Tennessee River Improvement Association, is conducting a survey of the Tennessee river and its tributaries, the work being conducted by the Corps of Engineers, U. S. Army. This river and its tributaries possess a large aggregate power capacity, the development of which will have a direct bearing on navigation. The survey includes a study of the resources of the basin to determine the influence of water transportation on their development and the amount of tonnage that they might contribute.

Public Comfort Station with Unusual Equipment

THE new public comfort station at Allentown, Pa., is located under Center Square to avoid renting or purchasing property and affords an unusual variety of accommodation. The structure is 65 x 55 ft., projecting under the sidewalk to provide for stairways with covered entrances. In the women's side are 6 lavatories, 3 free toilet rooms, 3 toilet rooms at 5c., 2 rest rooms at 10c. and one rest room with bath at 25c. In the men's side are 20 lavatories, 12 urinal stalls, 4 free toilet rooms, 5 toilet rooms at 5 and 10c. and 3 toilet rooms with shower baths at 25c. Coin locks are fitted to the doors of the pay rooms.

As it was specially desirable to avoid dampness the excavation was carried 2 ft. outside the walls to facilitate removing the forms and applying the waterproofing. After the footings had been poured the concrete was allowed to set for 2½ days before erecting the forms for the 12-in. walls. For these walls a dense concrete was made with a 1:2:4 mix having added to it hydrated lime and stone dust in proportions of 10 and 20 per cent of the weight of cement. Trap rock of ¼ to ¾-in. size was used, and the walls are reinforced with wire mesh. After the walls had been poured the plumbing pipes beneath the floor were laid and covered with a 6-in. slab, which was allowed to set for six days before erecting upon it the falsework for the roof forms.

As the two 27-ft. roof spans have to carry heavy trucking, a concrete T-beam and slab construction was adopted, the usual rod reinforcement being supplemented by a layer of steel mesh in the top of the 5-in. slab. This design was about 33 per cent cheaper than an alternative design with steel beams and it reduced the depth of excavation. The outside of the inclosing wall was given a coat of hot pitch and the trench was backfilled with wire mill cinders which were flushed and tamped. Finally the street surface was finished with asphalt paving.



PLAN OF COMFORT STATION AT ALLENTOWN, PA.

The interior arrangement provides free and pay accommodation for both sexes. Heating is by steam from the mains of a central heating company. For ventilation, foul air is drawn off through registers to conduits leading to an electrically driven exhaust fan, fresh air being admitted through the doors and by registers. All piping is laid in the ventilating con-

duit for accessibility, and the plumbing is ventilated to a 20-in. pipe inclosed in an ornamental concrete stack 20 ft. high. White enameled brick is used as the interior finish, with rounded edges at doorways and curved fillets at all corners to permit of thorough cleaning. An unusual feature is the use of electric air-drying devices at the free wash basins. By pressing a pedal a current of warm air is discharged, thus avoiding the use and nuisance of paper towels. Shoe shining stands, telephone booths and other conveniences are provided in both rooms. Two male and two female attendants work in 9-hour shifts from 6 a.m. to midnight.

This public comfort station was designed and constructed under the direction of H. F. Bascom, city engineer. Geo. H. Hardner was the general contractor. The total cost, including all fittings and equipment, was $40,000, half of which was paid by the county and half by the city, the latter raising its share by a bond issue. The station was opened in June, 1920.

Tile Drain Maintenance and Repair on U. S. R. S. Projects

Bedding in Gravel and Laying on Cradles Frequently Only Method of Preventing Settlement in Quicksand

DRAIN tile laid in gravel on the Shoshone Project of the U. S. Reclamation Service, where 85.85 miles have been put down by government forces, stand up well. Breaks have occurred only in quicksand and in every case the tile has settled and some has been broken. Invariably the tile was found filled with material, a hole showed in the backfill above the break and water flowed from the hole. Breaks are expensive to repair, averaging $10 per foot, and a special study has been made so that care in the construction may prevent failure. C. M. Jump, superintendent of irrigation on the Shoshone Project, has an article in the *Reclamation Record* for October giving details of maintenance, and A. R. McGinness, assistant engineer of the Huntley Project, describes in the same issue the method of building closed drains. The following abstract is from these articles:

It has been the practice on the Shoshone Project, wherever the grade of the drain is not in gravel, to use a cradle made of 2 x 4-in. lumber beveled on the edges and spaced so as to bring the support on the tile at the quarter points at an angle of 45 deg. to the horizontal and vertical axes of the tile. Some of these cradles have been used as short as 6 ft. in length, but at present no length shorter than 12 ft. is used. In exceptional cases where the subgrade has been in quicksand piling has been driven and the tile cradles hung in yokes on the piles. This piling has usually been of broken lagging boards.

The generally accepted practice has been to cover the upper five-eighths to three-fourths of the circumference of the tile at the joint with tar paper, thus leaving an opening at the lower portion where water can enter the tile line. As tight a joint as desired is not always obtained even by turning the tile in laying to secure the best possible fit. During construction water and muck often stand more than halfway up the tile.

Often water is forced up through the subgrade, which no doubt aids in forcing material into the tile and, in addition, keeps the subgrade loosened and in an unstable condition. Such conclusions as to the cause of the failures must of necessity be drawn from circumstantial evidence, but they are the result of several years' experience and embody the conclusions of project employees who have been interested in both the construction and maintenance of tile drains.

The problem of preventing such failures must be taken care of in the construction of the drain but there is no uniformity of opinion as to the best method. There is also considerable doubt whether a tile drain can be made a permanent success in quicksand or fine clay except at a cost that would be prohibitive.

Certain conclusions and suggestions may be offered: (1) To construct a tile line in quicksand or fine clay with gravel or to support it on ladders set on piling of sufficient bearing strength may make the cost prohibitive as compared with open-drain construction. To this may be added the doubtful permanency of such construction; (2) a tile line should have no rigid points of support. It should be allowed considerable flexibility so as to adjust itself to the different conditions of support. This is not practicable when drain tile is used. If it were practicable to use sewer pipe in such construction any deviation from a straight line would have a tendency to tighten the joint rather than to open it as is the case with drain tile.

Repair Methods — The general practice on the Shoshone Project in repairing breaks in tile drains is to begin opening the trench below the break where the water is running out of the top of the trench, since it is impossible to start a crib immediately over the break. This work consists of driving solid cribbing in sections 12 to 14 ft. in length, 3 or 4 ft. wide, depending upon the size of tile. In putting down these cribs 6 x 8-in. timbers are used as wales and 2 x 8-in. timbers for lagging or piling. The surface is taken off to a depth where the ground will stand up before the crib is started. The lagging is driven as fast as excavation is made to keep the banks from caving. When the first crib has been put down and the tile has been uncovered the drain is opened by taking out or breaking a tile, in order to lower the water so as to extend the crib over the break. Considerable care has to be used not to fill the down-stream section of tile with mud. In some cases it has been necessary to permit the water to come to the hydraulic gradient of the tile line and wait until the water table has lowered in the fall before the broken line can be relaid.

All this work requires hand labor and is very expensive as it usually takes from ten days to two weeks to open the line. If repairs are to be continued as in the past, instead of using wood piling or lagging, light steel sheet piling would be better and less expensive in the long run, as the timber is practically destroyed.

Trap Boxes — Another important feature in the maintenance of closed drains is the wooden trap boxes, which are beginning to deteriorate to such an extent that it will soon be necessary to repair or replace them. It is a simple matter to repair them temporarily by boarding up on the inside of the 4 x 4-in. posts used as the frame of the structure. This method, however, does not secure satisfactory construction, as the nailing must be relied upon entirely to hold the earth pressure. When decay starts it is usually the nail holes which soften first, so that the danger of collapse would be greater in the repaired structure than in the original construction. The water plane does not usually recede in the fall and show the necessity of repairs until so late in the season that the ground is frozen to such a depth that repairs from the outside would be very costly.

The life of a wooden structure alternately exposed to water and air, which is the condition obtaining in all trap boxes where repairs have been necessary, is 8 to 10 years.

Lining the trap box with a fairly thin concrete wall seems to be the simplest solution. This would support the old timber walls and would protect them from the deteriorating action of air and water. The trap boxes on the Shoshone Project are fairly uniform in dimensions, and it is believed that a collapsible metal form could be designed for this purpose, which, taken with the ease of obtaining materials, would allow an economical and efficient method for this repair, as well as obtaining a permanent structure.

Trap boxes are cleaned in the spring and fall. In the spring there is very little sand in the bottom of the boxes. In the fall, after the heavy run of water, the bottoms of the boxes are full of sand. It is a question whether it is necessary to clean these trap boxes, as there is plenty of room for sand to deposit at the end of drains and there has been no indication of sand lodging in the tile. At the time of constructing the drains it was believed that after a drain had been in operation for a year or so very little sand would get into them. But the drains that were constructed eight years ago are now carrying nearly the amount of sand that they did the year after construction.

Trouble With Drains in Sandy Soil

Construction of drains in quicksand, sandy loam and other material saturated with water is one of the most important features in connection with drainage on the Huntley Project. The first trouble with this class of material was in 1914, in the construction of a drain 6,953 ft. long. The slope where the greater part of the trouble has been experienced is 0.002.

For about 3,000 ft. the top soil was a heavy gumbo, exceedingly hard, but underlaid with quicksand, so that after the trench was opened and sheeted the sand flowed so continuously that it was necessary to remove it with buckets. Thus the banks on either side were undermined and the 6 ft. of gumbo was held in place only by the bracing. These banks usually cracked from 4 to 8 ft. back from the trench and gradually settled down, placing a great pressure on the sheeting and making the work dangerous. After about 3,800 ft. work was suspended temporarily, as the tile had become clogged with sand and it was necessary to go back 1,000 ft. to open it up. In doing the repair work the tile was uncovered at several points and in every instance was found to have settled vertically varying depths. It was then decided that the original plan of construction was at fault, and in the repair work or construction substantial ladders replaced those of lighter design and large quantities of gravel were hauled and placed under and around the tile.

The reconstruction was completed and the entire drain finally built, using what was at that time supposed to be good construction methods. Nevertheless, the drain has always given a great deal of trouble and each year has required the expenditure of considerable sums to keep it in operation. The major portion of the expenditure has been used in repairing breaks where tile settlement has occurred in quicksand or other unstable soil. Even the stiffer clays seem to disintegrate and become unstable, producing the same conditions that obtained in quicksand.

In the construction of a 4,156-ft. drain in 1917-18 4-in. timbers and 1 x 6-in. crossties 6 in. apart were used for the entire length of the drain. Quantities of large rock and gravel were rammed into the subgrade and the tile covered to a depth of 4 or 5 in. with good gravel. Approximately 16 cu.yd. of gravel to the station was used in the worst places.

Drain Lost — The drain gave good results and operated satisfactorily until March, 1919, when two or three breaks occurred in the line owing to tile settlement. These were repaired, and the drain was in successful operation until August, at which time about 1,200 ft. of the drain began to settle and finally became entirely clogged. Some repair work was attempted, but conditions became worse so fast that it was deemed inadvisable to continue.

The settlement seems to occur gradually, and apparently is caused by infiltration of sand from under the tile into the drain whence it is washed into the trap boxes. The first settlement is probably very small, and the tile joint is only slightly opened, but as the variation from grade becomes more pronounced the larger the joint opening becomes, the more rapidly the settlement proceeds. Instances have been noted where this vertical settlement has been as great as 6 ft. and equal to four or five times the diameter of the tile. Trap boxes with bottoms have settled as much as 2 or 3 ft. in some cases.

On the Shoshone Project one such failure occurred five years after construction and another three weeks after construction. In all these cases no special precautions had been taken, such as placing heavy ladders or surrounding the tile with gravel. Wherever failure has occurred in quicksand some broken tile have been found and settlement has taken place. Whether the tile were broken before settlement or after displacement it is hard to determine, though the indications are that they were broken during settlement.

Information from the North Platte Project, where a great deal of trouble with the drains similar to that on the Huntley and Shoshone projects is reported, reveals practically the same class of material with the same conditions obtaining. It has been necessary to construct portions of these drains as many as three times.

The first time some of these drains were built the material was dry. As soon as the ground became wet the tile began to settle out of line and soon the drain became plugged and was put out of commission. The second time these drains were built they were laid on cradles similar to the ones used on the Huntley Project, but no gravel was applied, the cradles simply being laid on a firm base. This method, however, proved unsuccessful, coinciding with experience on the Huntley Project.

The third time these drains were replaced piling was driven to refusal at intervals of 3 or 4 ft. In addition to the cradles and their supports gravel was placed around and especially under the tile. So far there has been no trouble with the lines thus constructed, provided the piles and supporting posts were placed at close enough intervals.

Open Drains a Last Resort

An important condition should be noted on the North Platte Project. It has been found impossible to construct drains through some of these places after the water table has risen 2 or 3 ft. above the grade line, except by building open drag-line ditches and then resorting to all manner of vertical and horizontal sheet piling, providing for upward as well as downward pressure on the tile in order to hold them in place. It follows that this kind of work is seldom done except for every short stretches and when the engineer is driven to it by the utmost necessity. Other- is seldom done except for very short stretches and when the water table is below grade. If such conditions are not obtainable then open drains constitute the only resort.

On the Huntley project, after the water table has once risen to a point where crops are endangered, it seldom recedes below any desirable grade line, therefore for our difficulties open drains would appear to be the solution, but these are impracticable from both a construction and a maintenance standpoint, and also because of the small farm units.

T. W. Macartney, drainage engineer, states that little difficulty has been experienced in Yakima County, Wash., with the drains constructed in quicksand or other mucky material where a sufficient foundation of gravel has been used. The method used is to have the pipe man or tile layer tramp in as much gravel as he can until a firm foundation has been made.

In the cases where extremely soft material was encountered approximately the same system of construction was used as on the Huntley Project; that is, boulders were rammed into place and then surfaced with finer gravel. Cradles were not used to any great extent. The amount of gravel and boulders used varied; in one instance 20 cu.yd. were used to the station. No case of failure or settlement on this work has yet been noted where sufficient gravel was used.

Summarizing the various construction methods noted it appears that cradles alone, cradles with gravel under and around the tile, and cradles supported on piling at too great distances have all proved unreliable in quicksand with the exception of the work at Yakima, Wash., regarding actual conditions of which we have very little information. Balanced against this we have cradles supported at frequent intervals (3 to 4 ft.) and gravel placed around the tile as the only successful method yet developed posi

tively to prevent the tile settling away from the original alignment. This method, however, is so expensive that it can be used only for short distances and in cases of extreme necessity. It would probably be impossible to accomplish this class of work where a trenching machine is doing the excavation.

One method suggested is the use of sewer pipe calked with a good filter material laid on substantial ladders and well blinded in gravel. Another suggestion is to use a wood-stave pipe the lower portion of which is solid and the upper portion perforated with holes and covered with a good filter material which would effectually screen out the minute solid particles, allowing only water to enter the pipe. The problem resolves itself into devising a method of building tile drains in such a manner that the water alone, with all solid material—such as sand, clays, loam, and various other soil ingredients—screened out, will have free access to the tile.

Brick Stack Ripped by Lightning Repaired While in Use

By P. S. Toney
Engineer, Sinclair Refining Co., East Chicago, Ind.

On June 14, lightning struck a stack at the Sinclair Refining Co., East Chicago, Ind., doing considerable damage. The stack is of the radial hollow brick type laid with lime cement mortar and having approximately the following dimensions: Height, 150 ft.; base diameter, 15 ft.; and top diameter, 11 ft. The ladder is inside the stack built up of separate rungs laid in every fourth course of brick. The rungs are made of ¾-in. round stock forged into the shape of a U, and with 2-in. hooks bent in the ends to fit down into the hollow tile securing the rungs firmly in place. The stack was erected by the Heine Chimney Co. and was completed in March of this year. It was not protected by lightning rods.

FIG. 1. STACK UNDERGOING REPAIR—NEW BRICK SHOWS EXTENT OF DAMAGE DONE

The lightning struck the top rim of the stack in a number of places, then followed down the ladder, jumping from rung to rung until it reached the breeching, from which point it had a metallic path to the ground. The top ring of the stack, though damaged in several places, was intact, and in no place was the ring broken completely through. This fact, no doubt, was due to the iron band laid in the brick work at that point. The first 50 ft. below the top were badly damaged, a hole varying from 12 to 30 in. being torn completely through the wall. For the following 25 ft. the stack was badly shattered and cracked so that part of it fell later. The remaining 35 ft. of stack, to the breeching, contained three or four cracks gradually reducing to one. A careful examination of the remainder of the stack disclosed no further damage.

A number of methods were proposed for repairing the stack, all of which could be carried out with a minimum shut down of plant. Chief among the methods suggested were the following: Pointing up the cracks and repairing the damaged portions of the brick work and banding; encasing the entire stack in a jacket of concrete properly reinforced and tapering from 8 in. at the bottom to 4 in. at the top using either an adjustable steel form or a cement gun to place the concrete; and, repairing by means of rebuilding and reinforcing the brick immediately about the damaged parts of the brick work, tying it into the uninjured portions with special reinforcing rods. The last method was decided upon as being cheaper, quicker and sightlier.

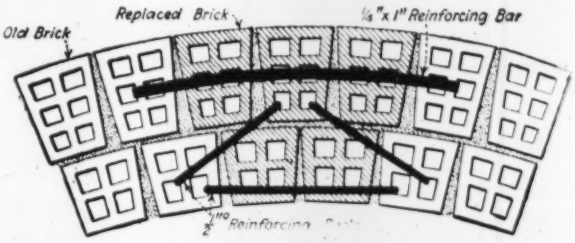


FIG. 2. TYPICAL METHOD OF REINFORCEMENT THROUGH EXTENT OF DAMAGE

As no great amount of material was needed at any one time a very light scaffold was sufficient. It was erected by placing a cable with a turnbuckle around the stack and hooking to this cable the brackets upon which the scaffold boards were laid. The scaffold was raised about 5 ft. at a time. To do this it was necessary only to fasten another cable above the first and with two extra brackets it was possible to raise the scaffold, using the material from the lower to build the upper, the last two brackets being raised from a swing.

Repairing was accomplished at first by reinforcing each fourth course, and increasing this to every course where the damage was greatest, enough brick being removed to allow the placing of the rods. The brick about the crack were replaced so that upon completion the only evidence of the damage was the new brick. Fig. 2 shows how the rods were placed. The rods were made on the job as needed of ½-in. round reinforcing steel, and ½-in. x 1-in. flat steel, each with a 1½-in. hook bent on either end. Great care was used in placing these hooks so that the new portion of the stack was securely anchored to the old on either side, the rods being interlaced and crossed until the outer courses were firmly secured to the inner. The stack was in use for the entire period during which it was being repaired. The contract for the repair work was let to Peter Drolshagen, Chicago.

Column Head Inclosures Insure Safety

Several men were injured recently by falling into unguarded holes in floor forms left for column heads. For the prevention of such accidents the *Travelers Standard*, which is issued by the engineering and inspection division of the Travelers Insurance Co. and the Travelers Indemnity Co. suggests a square inclosure composed of four posts, two sets of rails and a toe-board. When the columns have been poured the inclosures may be transferred to higher levels. In many cases inclosures should be stronger and of a more permanent character. Toe-boards should not be omitted especially when persons working on the lower floor might be struck by objects falling from above.

LETTERS TO THE EDITOR

New Spirit at New York Section Meetings

Sir—Your editorial note on the activities of the Western Society of Engineers in the Nov. 25 issue, p. 1017, prompts a reminder as to the changed atmosphere visible at the meetings of the New York Section of the American Society of Civil Engineers.

The regular meetings of the society in New York used to be a synonym for all that is dull and deadly in technical society meetings. By the careful selection of officers representative of all sections, independent in thought, eminent in the profession, but not blasé, and most willing to devote time and energy to the work, we have secured the long desired result of a live discussion of live topics, crowded and enthusiastic meetings and a real constructive interest by engineers in civic affairs.

It is not, as you point out, a large membership alone that secures this result but intelligent direction and hard work. I venture to hope that the same high purpose displayed in the selection of officers for the New York Section, whose ability and willingness to serve has been so eminently successful, may yet be displayed in the selection of a set of officers for the national body and so avoid a conflict of two opposing tickets whose members have been chosen, rather because they are conservatives or radicals, than because they can and will lead the society out of its present chaos. F. LAVIS,

Consulting Engineer, American International Corporation.

New York, Nov. 30.

Industrial Situation in France

Sir—The article in the Nov. 4 issue of *Engineering News-Record*, p. 876, entitled "Industrial Situation in France," by an American resident in Paris surely did not receive its proper title. The *raison d'être* of this article seems to appear in the last few paragraphs in which your correspondent gives light to his real thoughts. Furthermore, your correspondent did not have the courage to sign his name, evidently believing that with the rather sweeping statements that he makes, it would be best to keep under cover. This gentleman sees the straw in his brother's eye, but is serenely unconscious of any obstruction that is plainly affecting his own vision.

Gratitude and square deal? He should look up Webster and find out the meaning of these words. He is out of patience because Frenchy refuses to see things in the same color as he does and declines to accept blindly the well meant and conflicting advice of his friends. Frenchy is too individualistic; he listens respectfully to suggestions, but persists in rebuilding his house according to his own ideas; he believes that the rest of the world, particularly America, should pay the greatest part of his war losses; he refuses to tax himself; he discriminates against American goods; he is ungrateful, etc. Why did the gentleman stop there. Everybody is familiar with the propaganda carried on here for a generation back. Frenchy is immoral; he is fussy and excitable; he is degenerating; he is uncapable of doing serious work—all of which has been proven by the war.

Can the French really be expected to feel grateful? The war was fought out in his front yard and after it was over, the battling armies, Doughboys, Tommies, Fritz and others returned to their own unscathed firesides, but the Poilu remained amidst his ruins to mourn his two million dead. Naturally he expected his comrade in arms, who certainly did not fight for the love of the French alone, to stand by a bit and lend a hand. The world knows what help he received. Now some of his fighting partners are even trying to deprive him of the indemnity that he has a right to expect from the despoilers of his land.

The help the world is giving France may be compared to helping a neighbor when his house is afire in order to save ours next door, and after the danger is over tell him he should feel very grateful to us for our help—that since the cellar walls are still standing he can live in the cellar quite nicely with his family and that when he is ready to rebuild we will furnish the plans and loan him the money on his notes at 70 per cent discount. With the franc worth but 30 cents on the dollar, can we really blame the French for trying to restrict trade with us to the minimum? And this is not all. With the purchasing value of the dollar but 30 or 40 per cent of the pre-war basis, what can Franchy buy in America with his depreciated currency? Whether he wants to trade or not, he can't buy very much on such basis. France has great cause for provocation. Her chief partners feeling themselves secured and after depriving her of the very things she considered essential for her own safety and peace, are leaving her to battle alone.

Great Britain is already forgetting her murdered sailors and is getting back to old traditions of placing trade above everything. She is willing to sacrifice the future for immediate gain. She will follow her old policy of setting up rival interests on the continent of Europe ready to supply the balance of power against the most aggresive one, be it German, French or Russian. No wonder the French are sore.

We, at least, can say without fear of contradiction, that we have no axe to grind in Europe. Our only interest is to see that justice is done, but why have we placed Britain's interest above everything else. Only Mr. Wilson, of course, can answer that. Nevertheless, the French cannot but wonder why. The burden of taxes in France is five times higher than before the war—a greater increase than both in the United States and Great Britain. This certainly does not agree with your correspondent's statement.

Regarding his grievance about French individualism: French workmen have voted to work nine hours in place of eight. We certainly need some of this kind of individualism in this country.

Your correspondent did not seem to worry himself about stating facts. However, he probably said what he wanted to say, but his article would sound better dated from Berlin instead of Paris. GEORGE P. THOMAS,

President Thomas Spacing Machine Co.

Pittsburgh, Nov. 19.

Rail Improvement and Inspection

Sir—I have read with great interest your editorial in your issue of Nov. 18, p. 969, on "Successful Prophecy and the Future of Rail Quality," and as the quality of steel rails is a matter of such grave importance from every point of view I am glad that you have given it the prominence which an editorial article in your journal is sure to have, but I cannot agree with you in all your premises and deductions.

There is no question as to the improvement which has been made in the quality of steel rails during late years. In consequence of the increased weight and speed of the traffic which the rails have to bear a harder metal became a necessity, and as the element which, under existing knowledge, would give hardness without carrying with it dangerous brittleness is carbon, and as the element of phosphorus gives absolutely opposite effect, it became imperative that a lower phosphorus content steel would have to be used, and as the chemical character of the available ore supply of the country precluded the use of low phosphorus ores the basic openhearth process became a necessity. In other words, we have been enabled to produce a metal on a commercial basis by the use of that process which would have been impractical by the bessemer process. At the same time the basic openhearth as well as all other metallurgical processes has peculiarities of its own, which must be recognized and practiced upon such recognition to produce satisfactory results. The largest bessemer heat of steel was limited to about 15 tons, while, as is well known, the openhearth heats in many cases run as heavy as 100 tons. Therefore, a *bad* heat of bessemer was not as serious a matter as an unsatisfactory heat of openhearth steel.

You are quite right in your assumption that in most instances the unsatisfactory rails are what may be desig-

nated as sporadic and seldom apply to the general character of a large lot of rails. There is another fact, that these unsatisfactory rails can be, as a rule, traced to individual ingots of a heat. In other words, because some of the rails from individual ingots gave bad results it does not follow that the rails from the other ingots of the same heat should prove equally unsatisfactory.

I think it is well known how strongly I have for years taken the position that each ingot should be regarded as an individual factor, and it is of the greatest importance that all ingots should be sound castings, and that the only certain way to detect the character of the rails produced from each ingot is to make physical tests representing the product from each ingot, and that if such testing cannot be carried to so great a degree it should come as near it as is commercially practical.

The rationale of the whole proposition is that the operation in the openhearth furnace should be intelligently and properly conducted; then that the metal should be properly recarburized and deoxidized; then that the ingots should be cast sound; that they should be handled in a proper manner until their outer skins have been firmly set; that their subsequent treatment in the soaking pits should be intelligently conducted, following which, that the rolling process should be one of intelligence and care, this covering the reductions and manner of reductions of the ingot into the rolled rail of the desired section; that the sawing of the ends should be carefully executed and the manipulation or handling of the steel upon the hot beds should be carefully done, and if the rails are to be cold straightened under existing presses that the rails should go to them from the hot beds in a condition requiring the minimum of that practice; and finally that the ends of the rails should be finished square, and this can only be done by milling them.

You say, "we cannot safeguard ourselves against a return to the more dangerous rails of ten years ago merely by pleading with the producers to be careful! We must translate our request into terms of procedure to be followed, properties desired, or tests to be met. This may become possible when the steel men reveal the secret of their campaign for rail improvement." And you have previously stated in your article, "Nor is more careful inspection a probable factor. It seems necessary to conclude that the improvement was brought about in part, if not wholly, by persistent effort of the steel-mill men themselves."

You will permit me to say that in my judgment there is no secret or mystery surrounding the production of good rails, as it is well known that the careful observation of certain procedures will inevitably result in their production. It may be undetermined as to exactly what deviation from such good practice will result in certain defects, but, as stated, the fact is that if none of those deviations are permitted the "mysterious" defects will not occur.

Reverting to your assumption that more careful inspection has not been a probable factor in the improvement of rails, I would beg to differ with you, which difference, I believe, is borne out by my own experience. Julius Kruttschnitt, then director of maintenance and operations of the Harriman Lines, and John D. Isaacs, consulting engineer of the same large system, were not satisfied with the results they were obtaining from their rails and became convinced that a more thorough and comprehensive inspection than had yet prevailed would be a desirable procedure, and as my firm were inspecting under the then accepted practice all the rails which they purchased they consulted with me as to the practicability of establishing a more thorough system of inspection, and expressed their willingness to meet the greater expense which would be inevitably incident to such a procedure.

I was convinced as to the practicability of the more thorough and complete inspection scheme, and we arranged that we should establish it for them, but almost immediately folllowing my interview with them, when this agreement was reached, I was enabled to lay the matter before the late William A. Gardner, then president of the Chicago and Northwestern Ry. Co., and Daniel Willard, president of the Baltimore & Ohic R.R., with the result that both of those gentlemen expressed their willingness, and in fact pleasure, of joining in my scheme. With that additional support, my firm saw their way clear to inaugurate what has since been known as "Special Inspection" at all the rail millls of the United States and Canada, feeling confident that we would receive the support of a large number of our other clients, and, therefore, the "Special Inspection" was established for the rails produced in 1912, and it has been, as anticipated, adopted by nearly all of our patrons, with the result that since that time we have covered by that system about 8,000,000 tons of rails produced in the various rail mills of the United States and Canada. That at least encouraging results have been obtained, we refer to the published statistics of the American Railway Engineering Association, of which, as you know, Mr. Wickhorst is the engineer of tests of the rail committee.

From the association's reports of failed rails for the period ending Oct. 31, 1918, it was shown that there were 18,641 track-miles of rails covered by the "Special Inspection" method, and the total number of failures amounted to 35.6 per 100 track-miles. On the remaining 24,090 miles reported and on which "Special Inspection" was not performed, there were 51.9 per 100 track-miles of failures shown. Based on these figures it would seem that the application of "Special Inspection" had resulted in a saving of, roughly, 30 per cent in the number of failures, which results certainly would seem to controvert your assumption that more careful inspection was not a probable factor in any improvement which had taken place.

As playing an important part in the satisfactory results obtained from "Special Inspection," I am fully convinced that the personal responsibility which it established among the mill operations has been a large factor. As is well known, all the skilled workmen are paid by the ton of production, and therefore the more produced the larger their pay, and under the old procedure, as there was no means of personal identification attached to the product, it naturally led to the absence of the feeling of personal responsibility. On the other hand, under the procedure of "Special Inspection" every rail carries with it a means of analyzing its history from the time the steel leaves the openhearth furnace until it is loaded upon the cars for shipment, and means of identifying the actual workmen in the several departments who took part in the manufacture of that rail. The existence of this condition has led to a realization by the men of personal responsibility, and naturally a personal pride in the result of their work; and instead of causing trouble in the operation of the works, as at first was feared it might, it has produced exactly the opposite effect, as no one can be held responsible for another man's careless work.

You undoubtedly are quite right in your feeling that the stress of the war time, attended as it was by a slackening in the demand for steel rails, had an effect of diverting the attention of the steel-mill engineers to other and for the moment more important steel products, but as the railways have, under existing conditions, again become purchasers of rails, and, thank Providence, the war demands have ceased, I feel confident that the improvement in the character of rails produced will continue, but not so much through the discovery of new things as the avoidance of those things already known, and surely the prominence given to the matter by such articles as yours will help to bring about the desired results.

ROBERT W. HUNT,

Chicago, Nov. 26. Robert W. Hunt & Co., Engineers.

[Our editorial remark "Nor is more careful inspection a probable factor" was meant to apply to new ways of determining the quality of rails or checking up their uniformity. The not very appropriate term "careful" obviously invites protest in the sense of Mr. Hunt's comments, and his demonstration of the large influence exerted by the psychological factor in inspection contributes a valuable element to public knowledge of the rail problem. Does it not also tend to support our suggestion that the recorded improvement in rails during the past half-dozen years "was brought about in part by the persistent effort of the steel-mill men themselves"?

Though the point is perhaps only incidental to Mr. Hunt's argument, his statement that the unsatisfactory rails can be

traced to individual ingots of a heat is so important that we believe it should be tested critically and as soon as possible either proved or disproved. If the ingot is at fault then the heat is not at fault, and uncertainty as to where to look for the sore spots in present practice is greatly narrowed. But a good bit of circumstantial evidence that bad rails run in heats has already been put on record, and, as our editorial undertook to show, the purely statistical evidence points the same way. On the basis of this evidence ingot practice would be a secondary though possibly a necessary factor. The problem would be greatly simplified if the particular question here involved could be decided at the earliest possible moment.—EDITOR.]

United States Should Be a Member of International Road Congress

Sir—The First International Road Congress was held in Paris in 1908. At this congress the Permanent International Association of Road Congresses was formed with headquarters in Paris. The second congress was held in Brussels in 1910.

The third international road congress was held in London in 1913, at which time there were 3,793 members of the association. The business sessions occupied about one week and were devoted to a thorough discussion of the subject matter of 123 reports pertaining to the 19 topics on the program. During the final business session, progressive conclusions relative to each topic were adopted.

The government of the United States is the only world power not a member of the association.

The international commission of the Permanent International Association of Road Congresses, at its meeting held in Paris, June 21, 1920, unanimously voted to accept an invitation to hold the fourth congress in the United States in 1922, provided an invitation from the United States government is received by the executive committee of the association before Jan. 1, 1921. If an invitation is not received from the United States on or before Dec. 31, 1920, the invitation from the Italian government will be accepted.

As a regulation of the association stipulates that an international congress cannot be held in a country whose government is not a permanent member of the association, it will be necessary for the United States Congress during December, 1920, to pass an appropriation which will provide for the annual subsidy of the United States as a government member of the association and which will enable the Secretary of State to extend an official invitation to the association to hold the fourth congress in the United States in 1922.

The object of the association is to promote progress in the improvement of highways and the efficiency of highway transport throughout the world. The work of the association consists in organizing international road congresses, publishing reports, papers, proceedings and other documents and collecting information relative to highway improvement and highway transportation. The membership of the association consists of representatives of governments, delegates of corporations and individual or private members. Each government has the right to one representative for each 1,000 francs of its total annual subsidy, provided, however, that the number of representatives from any one government does not exceed fifteen.

Individual or private members pay annual dues of 10 francs, or compound for a life subscription by the payment of one sum of 125 francs. Due to the current rate of foreign exchange, it is practicable for Americans to become life members by the payment of the subscription of 125 francs through the medium of a bank draft, which will cost, at the present time, between $9.50 and $10. Life membership dues should not be sent by an international postal money order, as an order for 125 francs will cost approximately $25. Bank drafts should be made payable to the Permanent International Association of Road Congresses and be sent to Professor Paul LeGavrian, general secretary, Permanent International Association of Road Congresses, 1 Avenue d'Iena, Paris, France.

Individual members receive, free of charge, all of the publications of the association. The reports and proceedings of the third congress measure, when stacked, about 6½ x 9½ in. by 8 in. in height. Members also receive the bulletin of the association. All the literature sent to American members is printed in English.

The international association should be supported by Americans who wish to see the science and art of highway improvement and highway transport rapidly develop throughout the world, who believe in an international medium for the exchange of opinions and conclusions, and who wish to be well informed relative to progress in highway engineering and transportation in foreign countries. Americans should not be satisfied with joining the association as individual members. Although every courtesy was extended to the United States members of the association at Paris, Brussells and London, nevertheless every American who has attended an international road congress has wished to apologize because his Government was not a permanent member of the association.

Considering the phenomenal development of highway improvement and highway transport in the United States, and the active part which the United States Government is taking in highway construction through the medium of the Federal-Aid Act, it requires no elaborate arguments to demonstrate the advisability of the United States Government becoming a permanent member of the association. The status of the United States as a leading world power demands that its annual subsidy should be the maximum allowed by the constitution of the association, that is, 15,000 francs, which will provide for fifteen representatives of the United States on the permanent international commission. It is the duty of every American who wishes to support the work of the international association and to have an international road congress held in the United States in 1922 to write to his representative in Congress, where it is hoped the necessary bills will soon be introduced, urging them to vote favorably on an appropriation to provide for the annual subsidy of the United States as a government member of the Permanent International Association of Road Congresses.

ARTHUR H. BLANCHARD,
Professor of Highway Engineering,
University of Michigan.
Ann Arbor, Mich.

Engineers and the Law

Sir—At a recent meeting of the Boston chapter of the American Association of Engineers, Thornton P. Alexander, attorney for the Boston & Maine R.R. and past major in the construction division of the United States Army during the war, spoke on the topic "As the Lawyer Sees the Engineer." Both the lawyer and the engineer, in order to properly serve their clients, must study their problems analytically and construct synthetically the framework of data upon which they form their judgments. But whereas the lawyer deals with laws which are variable and unsettled the laws of engineering are founded in nature itself and are steady and unshaken. Each must be careful to employ thoroughness of research and to use soundness of judgment.

Mr. Alexander then went on to say that many engineers neglect the fact of the existence of law and see that their projects line up with the principles of law. Thus many troubles have arisen through neglect to investigate what laws are on the statute books regarding navigable waters. Upon receiving a contract for a bridge over a stream or a wharf extending into the waterway the engineer may proceed to design the structure without investigating what kinds of bridges or wharves are restricted by law or what the laws have to say about such construction. Even though the stream may be small it may be called "navigable" on the statute books. He must obtain a license by the state or the government, or have his plans approved by the government, or he may be forced to pull out his structure after it is built.

Regarding contracts Mr. Alexander mentioned the fact that care must be taken in drawing them up, they must be clear and definite, there must be no loop holes through

which unscrupulous subcontractors or workers can crawl. Care must be taken also to see that the construction agreement is clear and definite, and that all plans and specifications are correct, for if trouble results from the use of these he is responsible. The engineer must also see that the object of the project is not against the law, as work which is done on unlawful projects need not be paid for.

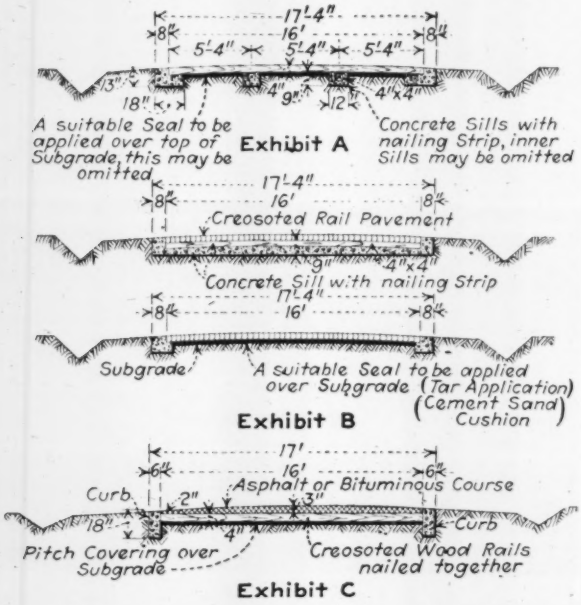
Touching upon the part that engineers take on the witness stand he stated that they must be fully prepared through training and experience and careful study to make proper statements and decisions, that they must present the case openly and fairly but not too zealously, and they must speak without conceit.

L. B. COREY.

Stoneham, Mass., Nov. 27.

Proposes Creosoted Rail Pavement for Long Life Under Traffic

Gentlemen—The accompanying sketches show a proposed creosoted rail pavement. Exhibit *A* is the lateral rail system, showing timbers laid at right angles to the center line of the road supported by longitudinal concrete sills imbedded in the subgrade, with nailing strips, as shown. The nails are toe-nailed into the nailing strips and the rails to each other. The nailing system is designed to develop beam sections of sufficient strength to carry the various pavement stresses. The strips will be edge grain, and there could be an argument advanced that the pavement would not stand the wear, but the writer truly believes that if an asphalt filler is applied, forming a coating over the wood surface which would keep the wood from wearing, that a high-class pavement would be developed. Depression to a great



THREE CROSS-SECTIONS OF PROPOSED RAIL PAVEMENT —EXHIBIT *A*, RAILS LAID LATERALLY; EXHIBIT *B*, RAILS LAID LONGITUDINALLY; EXHIBIT *C*, ASPHALT TOPPNG USED

extent would be eliminated. No doubt there would be a certain resiliency in the pavement which would mean easy riding for the motorist. Exhibit *B* shows the rails laid longitudinally. It has an advantage over exhibit *A*, in that the rails will take the roadway crown.

The writer also contends that a pavement developed by nailing creosoted lumber together to form a base, for instance, laid on a cement-sand cushion with an asphalt applied over the top as shown in exhibit *C*, would result in a permanent pavement of long life. It is well at this time when enormous sums are being expended to improve highways, to investigate and calculate if some different design in pavements will not carry the heavy loading to better advantage than those now in standard practice.

The cost of the creosoted rail type of pavement will run somewhat high for the various types which are shown. Taking exhibit *B*, and omitting the roadway edging, but retaining the lateral sills with nailing strips, an approximate cost per sq.yd. is as follows:

Lumber (including nailing strips in concrete sills)	$3.83
Concrete (1 : 2½ : 5) sills	.40
Asphalt filler	.25
Nails	.08
Laying	.10
Fine grading	.08
Bond and insurance	.02
Incidentals	.10
Overhead	.10
Actual cost	$4.97
Profit	.50
Cost with 10 per cent profit	$5.47

According to the present prices of pavements this cost is not prohibitive.

It occurred to me that a concrete slab in place of the wood surfacing, using the concrete sills as abutments or slab supports, might work out very nicely. You could place the reinforcing in tension and figure your steel area and slab thickness. This will give a definite way to know the loadings a highway or street will carry.

EARL A. SMITH,
President, Smith-Foster Co.

Dayton, Ohio, Sept. 16.

Why Reservoir Stations Are Not Used in New York Subways

Sir—Your recent articles on subway stations [Oct. 28 and Nov. 4, pp. 824 and 894] are very well presented, and the reference to "reservoir stations" was of particular interest. Had stations of this character been introduced at a few of the important points of the dual subway the capacity of the subway would have been increased 50 per cent with comparatively little increase of cost. The Brooklyn Bridge formerly operated with an arrangement of this kind and had a loading capacity through the station of 60,000 passengers per hour—on a single-track railroad, using trains of only five cars. This was well known as the greatest passenger traffic in the world for a single-track line, and its operation was studied by all transportation engineers.

A "facing-point switch" has been mentioned as an objection and a source of possible danger in applying the reservoir station to subway operation, but as a matter of fact there is no "facing-point switch" in the usual acceptance of that term and from which dangerous operation arises. Every switch, when used, has facing points and this one is no different from others, but it is merely a switch leading into a station, is not used at high speed (in fact, high speed is not used in the subways), and there would be no loss of subway capacity if this switch were used under a controlled limit of speed. A "facing-point switch" on the main line of a railroad, where express trains travel at 60 miles per hour or faster, becomes a danger because, if misplaced, the train will not take the switch, but will be derailed and overthrown. Such would not be the condition here.

While the original proposal to introduce these stations into subway practice was merely an adaptation of the principle so successfully used for years on the Brooklyn Bridge, its adoption was approved by Bion J. Arnold of Chicago, who gave the station the name of "reservoir station," which very aptly and correctly describes its function in railroad operation. The first plans of the Triborough Subway had reservoir stations at 42d St., 86th St. and elsewhere. A member of the lay Public Service Commission raised the question of "facing-point switches," however, and by ruling out the reservoir stations reduced the capacity of the subway 30 per cent, increased the cost from $116,000,000 to $119,000,000, and the commission and its chief engineer parted company, if I remember correctly.

HENRY B. SEAMAN,
Consulting Engineer

New York City, Nov. 10.

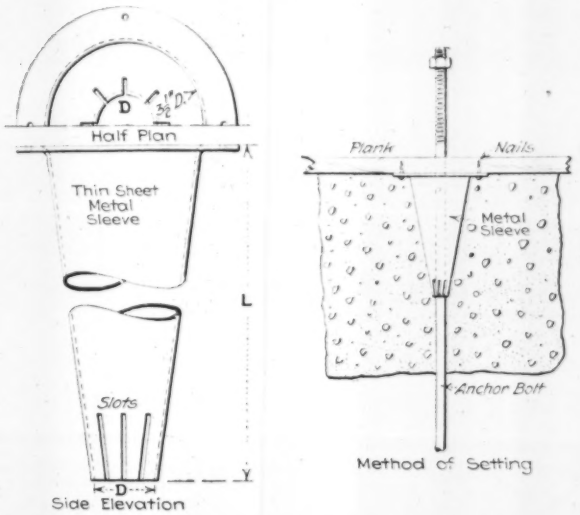
HINTS FOR THE CONTRACTOR

Device for Setting Anchor Bolts

By John H. Sawkins
Schenectady, N. Y.

A CHEAP means for the accurate setting of anchor bolts in concrete foundations is provided by the metal sleeve shown in the accompanying drawing. This simple device consists of a thin metal cone provided with a lip at the larger end so that it may be nailed to planking fixed at the upper level of the concrete, as shown. The lower end of the cone is slotted to provide a close fit with various diameters of bolts, the diameter *D* ranging from ⅜ to 2 in. The length, *L*, ranges from 6 to 24 in. the longer lengths being used for the heavier bolts.

After the concrete has set the sleeve is easily removed



SLEEVE FOR ANCHOR BOLTS

and if care is exercised the same sleeve may be used several times. The 3½-in. diameter at the top allows the bolt to be accurately centered by bending it slightly. The space around the bolt may afterwards be filled with grout. This device has been used successfully by the Grounds and Buildings Department of the General Electric Co., Schenectady, N. Y.

Be Careful or Lose Your Job!

That "safety first" is a condition in holding a job and that accidents due to carelessness of workmen or foremen will lead to the discharge of those responsible is the keynote of a safety bulletin issued by Fred T. Ley & Co., contractors, Springfield, Mass., and signed by C. C. Clough, superintendent. After pointing out that carelessness, incompetency and negligence are the causes of 99 per cent of the accidents on construction work, Mr. Clough's circular says:

"In the future any employee on the job injured through his own carelessness need expect no consideration in prolonging his stay on the job.

"Foremen will be held strictly responsible for accidents occurring to men in their charge. Any accident due to negligence of a foreman will materially affect the length of his stay on this job. Watch your step. Look out below. Pull those nails. Cover that shot. Don't bunch on that scaffold."

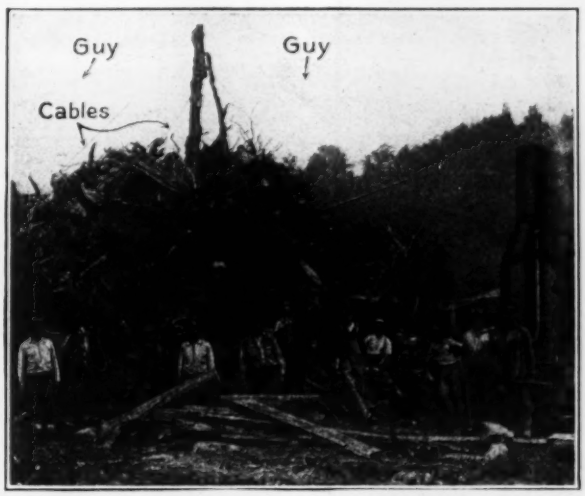
Stumps Pulled and Piled by Gin Poles

By Jacob L. Crane, Jr.
With Gannett, Seelye & Fleming, Inc., Harrisburg, Pa.

RAPID progress in clearing the 30-acre site of an earth fill dam for the Girard Water Co., near Ringtown, Pa., was effected by an improved gin-pole rig. Two types of horse operated stump pullers were used at first, but even with the aid of dynamite to loosen the roots the process was slow and expensive, as was also that of dragging out the stumps by horses after the use of dynamite. This latter process required from 16 to 20 horses to loosen the stumps and 4 to 6 horses to drag and pile the stumps for burning.

To expedite the work a gin pole arrangement was devised, a 30-ft. pole being erected and guyed to four stumps, with a double-drum engine braced against it and having ⅝-in. cables led through two pulleys at the top of the pole, as shown in the accompanying view. These pulleys are mounted in hangers which stand out horizontally for long reaches, the working radius of the cables being about 440 ft. When the stumps are loosened by dynamite they are easily dragged out of the ground and up to the pole, incidentally loosening and clearing away the surface vegetable matter. They are piled to the height of the pulleys, which are then detached, a new pole being cut for each pile of stumps.

A crew of eleven men with two mules averaged 50 stumps per hour, pulled and piled for burning. Besides the foreman (who did the blasting), an engineman and a fireman, there were four men and a mule to each cable; one man drove the mule to haul out the cable, two men fastened it to the stump, which they trimmed and notched if necessary, and one man detached the cable at the pile. The work was done at greater speed



GIN-POLE RIG FOR HANDLING STUMPS

than by the old method and at less cost, even including hoist rental, repairs and fuel. This scheme was devised by Thomas Kelshaw, superintendent of the Girard Water Co., who has direct charge of the construction of the dam and is building it on force account for the company. James Archbald is general manager. Gannett, Seelye & Fleming, Harrisburg, Pa., are the engineers for this work.

Dragline Excavates Pits for Bridge Foundations

By Chas. H. Paul

Assistant Chief Engineer, Miami Conservency District

INSTEAD of enclosing the pier foundation in separate pile cofferdams in building the Black Street Bridge at Hamilton, Ohio, large pits were scooped out by dragline excavator and the banks built up to hold back the water.

PIT EXCAVATED BY DRAGLINE FOR TWO ADJACENT BRIDGE PIERS

One of these pits, as is indicated by the illustration, was excavated large enough to include the foundations of two piers.

The Black Street Bridge is a seven-span concrete arch structure being built across the Miami River by the Miami Conservency District. Construction of the piers has been by force account and the superstructure may be built in the same manner or by contract as will later on be decided.

In place of a steel sheet pile cofferdam for each foundation, which is the common practice in this valley, we scooped out a hole with the dragline machine, pumped it out without any difficulty (although most of the pier foundations are 15 to 20 ft. below water surface), hung the leads from the end of the boom and drove the foundation piles, and for the first two piers before the cableway was erected used the dragline also for placing the concrete. This particular view shows the excavation for two piers, the first and second out from the west bank of the river. In this case it worked out best to excavate *both at once*, and to throw the whole river out of the way beyond the next pier. The pile foundation for one of these piers has been driven and the form work is being started. The other pier will be located in the foreground close to the toe of the slope of the excavation.

This view is taken from one of the cableway towers and therefore does not give a proper idea of the depth of the excavation. The pier foundation where the piles are driven is about 15 ft. below river surface, and the one toward the foreground will be within 3 or 4 ft. of that depth. The cableway is being used for handling the form material, etc. and for placing the concrete. The concrete mixing plant is just in front of the head tower, which is visible in the distance.

The work is under the direct charge of C. H. Eiffert, division engineer; W. T. Rains, general superintendent, and W. A. Roush, superintendent on concrete.

Charring Posts of No Value

Service tests made by the Forest Products Laboratory on fences whose posts were charred at the lower end to prevent decay, in comparison with fences having untreated posts, showed that the charred posts were if anything less durable than the uncharred posts. It is concluded by the laboratory that charring is of little value in protecting the butts of fence posts and telephone poles from decay. One reason for the conclusion, apart from the test results, is that the charring is unlikely to reach to the bottom of season checks and similar depressions in the surface of the wood.

NEWS OF THE WEEK

New York, December 9, 1920

Seven Further Amendments Before Civil Engineers

New proposals to amend the constitution of the American Society of Civil Engineers have just been placed before the membership for discussion at the annual meeting, Jan. 19. Two of these proposals relate to officers and nomination, one to the selection and function of the secretary, one to local sections, one to local sections and an annual conference, one to officers, nominations and local sections, and one to public relations and personal welfare.

Revision of Kansas Water Laws

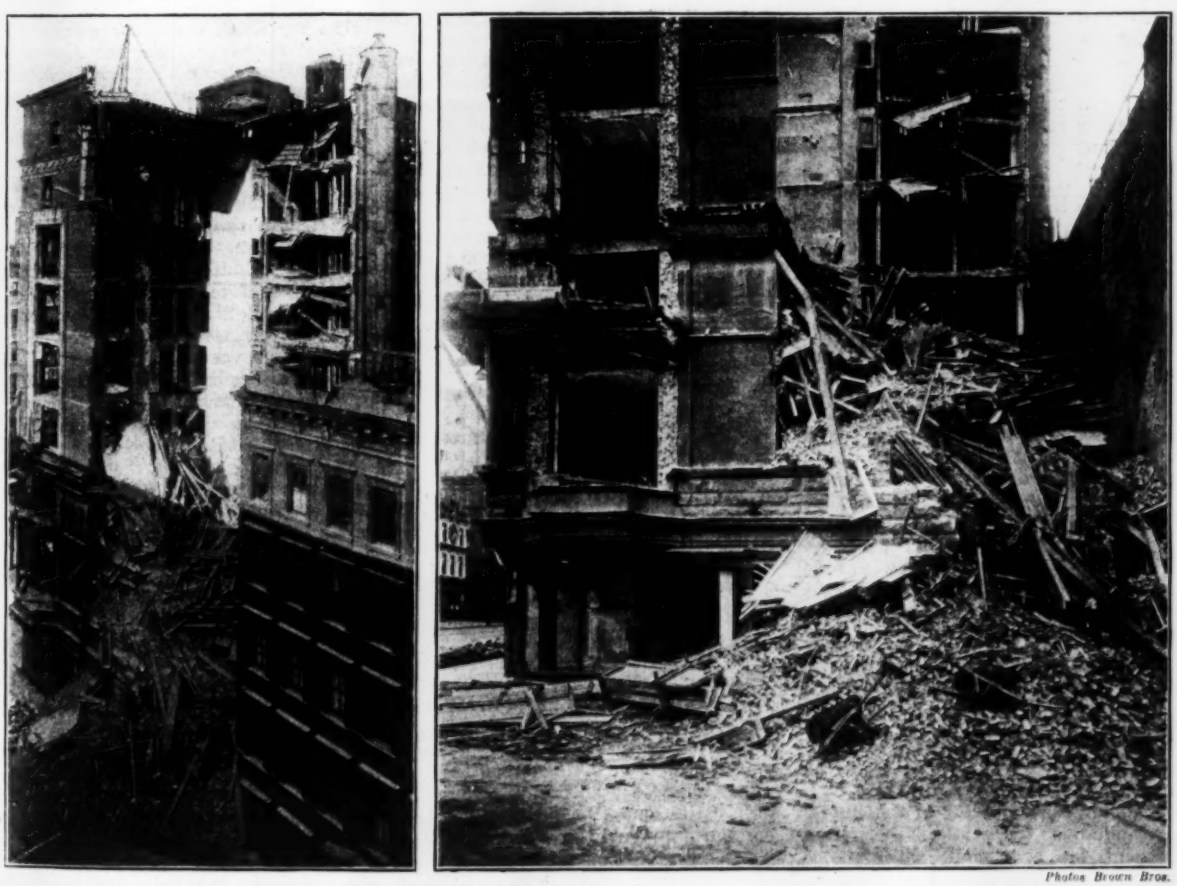
A state congress to discuss changes in state legislation on floods, drainage, water power, irrigation and navigation, as recommended by the Kansas Water Commission in its second biennial report, has been called by Governor H. J. Allen to meet at Topeka on Dec. 15. Representatives of cities, counties and drainage districts as well as "all others who are interested in the subject" are invited to attend.

Part of Old Nine-Story Building Collapses During Reconstruction

Weak Rear Wall of New York Apartment Crushes—Difficult Underpinning of Front Walls Believed Not Involved

Sudden collapse of a 30 x 30-ft. section of the nine-story Strathmore apartment house at the northeast corner of 52nd St. and Broadway, New York City, on Dec. 1, caused the death of one workman, injured about a dozen persons, and blocked a number of important arteries of traffic for a time. The accident occurred in the course of extensive reconstruction operations, which were to convert the lower stories of the building for commercial use by the placing of steel columns to support the major part of the front walls and interior of the building. The collapse affected one corner of the rear portion of the building, where the difficult and delicate underpinning work preparatory to setting these columns was not being carried on. So far as determined up to the present the accident was not caused by or connected with this underpinning. Failure of half of the rear wall of the building by crushing or "buckling" is responsible for the failure, in the opinion of the building authorities of the city.

The Strathmore building measures about 70 ft. on the Broadway and 62 ft. on the 52nd St. sides. It consists of brick walls and wood joist floors, and was built in the early '80's. Numerous changes in the structure were made at several subsequent dates, the most extensive being the insertion of steel floor girders in the first and second floors along the two street fronts, and columns to replace many of the brick walls at these girders. The floors were of decidedly unusual construction,



Photos Brown Bros.

STRATHMORE RUINS FROM SOUTHEAST AND SOUTH (BROADWAY AT LEFT)—FAILURE ATTRIBUTED TO WEAKNESS OF WALL AT RIGHT

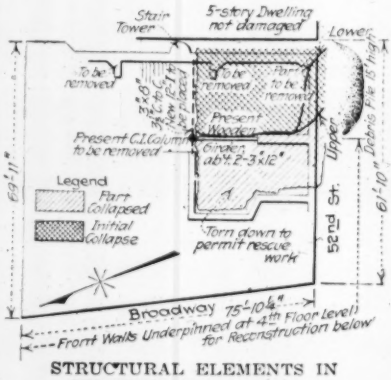
consisting largely of 3 x 8-in. joists set nearly solid (3½ in. on centers), and in part of 3 x 8's 5 in. on centers. In the easterly part of the building, where the collapse occurred, these joists ran east and west, spanning about 18 ft. from interior wall and girder supports to the east wall of the building, where they rested on a corbel course of the brick wall, their ends barely entering the wall. The brickwork generally, except for portions involved in the subsequent alterations, was laid up in lime mortar. However, in spite of some cracking that developed during an alteration eight years ago, the structure appears to have been in satisfactory condition and was generally described by the building authorities as "a substantial structure of massive character."

In order to convert the building to more modern business use, its reconstruction by placing columns in the first story and rearranging the interior was recently begun by the lessees, Walter J. Salmon & Co., of New York City, under plans drawn by their architect, J. Kleinberger, and carried out by the Paul Chapman Construction Co. In the conduct of the work the wall piers on Broadway and 52nd St., the west and south sides of the building, were needled at the fourth-floor level by double sets of I-beam needles, one about 2 ft. above the other, between which were inserted blocking girders parallel to the wall on the inside and outside. The portion of wall between the sets of needles being then cut out, wall girders were being inserted, preparatory to placing columns below. While this work and reconstruction of some interior partitions were in progress, about 1:30 p.m., Dec. 1, the two south panels at the east wall of the building and the entire north half of the east wall collapsed without prior warning. The failure was sufficiently gradual that several persons in an automobile salesroom occupying the floor at the corner managed to escape. Only a few workmen were in the building, but only one was caught in the collapse and killed. Several hours later some loose sections of wall and floor were pulled down, and these carried other parts with them, about doubling the failure area.

In the collapse section all floors, the entire south half of the east wall, and the east half of the south wall, and an interior bearing partition parallel to the east wall and carrying the inner end of the span of joists bearing on this wall, are down, from second-floor level to roof. The two exterior walls involved in the collapse are cut off along fairly vertical lines through window openings. The remainder of the structure does not appear to be seriously disturbed.

According to eye witnesses and F. C. Kuehnle, chief inspector of the Bureau of Buildings, the seat of the failure was at the east wall, which failed, possibly from some local overloading. Mr. Kuehnle believes that this wall buckled near the third-floor level. The reconstruction plans provided for cutting out some fireplace brickwork integral with this wall, in the southeast corner of the building and at a point about 20 ft. north of here, but it is not known whether this work was in progress at the time. The wall piers at these points carried a number of smoke flues. It is claimed that some shoring and other material had been piled near the east wall shortly before the failure, increasing the load on the wall.

An interior wooden girder, a double header-beam apparently of two 3 x 12 timbers, carrying the westerly end of the span of joists resting on the east



STRUCTURAL ELEMENTS IN STRATHMORE COLLAPSE

wall, and shown in the plan sketch, is broken off at its seat on the cast-iron column supporting its north end, at each floor. This is believed to have been broken down by the second collapse. The early appearance of the wreckage indicated a movement toward the east side of the building, and the later fall moved partly to the south, but only a very small amount of débris fell outside the lines of the building itself. East of the building and separated from it by a narrow court 4 or 5 ft. wide is a five-story brick dwelling house of ordinary type. This structure apparently was not injured by the collapse, although the lower portion of the court is filled up to the height of the second-story level. On the south side the débris mainly occupied the north half of the street.

Fuller investigation of the case is in progress in charge of officials of the Building Department and of the District Attorney's office. No statement of fact or cause was obtainable from the contractors.

Dr. Tudsbery to Retire

The early retirement of Dr. J. H. T. Tudsbery as secretary of the Institution of Civil Engineers (London) has been announced, with the fuller statement that it has been decided that his successor must be a corporate member of the Institution. Dr. Tudsbery, whose portrait was published in *Engineering News-Record*, Nov. 4, p. 901, has been secretary since 1896 and has had much to do with the growth of the Institution and its work.

German Industries Receive Foreign Orders for Equipment

The German-Chilean firm Saavedra Benard representing the Maschinenfabrik Augsburg-Nurnberg A. G. has closed a contract with the Chilean Government for eight electric cranes of 3 tons capacity each and fourteen of 1½ tons capacity, which are intended for use in the harbor of Valparaiso. The purchase price is 1,200,000 gold pesos. This is the first large Government order from Chile since the war. The Norddeutsche Seekabelwerk Noordam has received an order from the Dutch Government for cables for the Dutch Indies, which will keep the works fully employed for several months.

Another order for electric cables from the Swiss Government has been placed with Siemens & Halske. This order, amounting to 2,500,000 francs, has been given for immediate delivery. Siemens & Halske had the cables ready for the German-Telegraph Administration, which, however, withdrew from the contract in favor of the export to Switzerland. The same company received a large order for electric machinery for Chinese mines, railroads and industrial establishments. This order has been secured in competition with American, English and French manufacturers, which have been considerably underbid by Siemens & Halske.

The A. E. G. electric company has received an order from the North of England for electric material amounting to £200,000. Another English order has been given to the Orenstein & Koppel A. G. for mine equipment and narrow gage railroads, and to the Linke Hoffman-Werke, one of the largest railway-car building works in Germany, for special purpose machinery.

The German ship-building industry is nearly to half of the manufacturing capacity employed with foreign orders. The shipbuilding works of Schichau have lately received an order for three cargo steamers equipped with turbines, which are the first of their kind to be built in Germany. The reduction of speed between the turbine shaft and the screw shaft is done by a gear which is patented to Schichau. The ships have a tonnage of 7,300, the turbines having 1,600 hp. each. Two steamers of the same type have been ordered by a shipping firm in Finland.

Health Conference Organized

A "health conference," to include health officials in cities of 100,000 and more, was organized during the recent health and housing conference held at Detroit. Dr. Royal S. Copeland, health commissioner, New York City, was made chairman and Dr. Henry F. Vaughan, health officer of Detroit, was made secretary. Dr. Vaughan is an engineer. The first meeting of the new organization will be held in New York City, October, 1921, in connection with the meeting of the American Public Health Association.

Oppose Plan for Destroying High Bridge

Civil Engineers Discuss Means of Saving Historic Structure Now Obstacle to Navigation

Active discussion of the War Department's demand that High Bridge, carrying the first Croton aqueduct over the Harlem River into New York City, be removed as an obstacle to navigation, and various subsequent projects for reconstructing the bridge with larger channel openings, marked the meeting of the American Society of Civil Engineers in New York Dec. 1.

Nelson P. Lewis, chief engineer of the city's Board of Estimate and Apportionment; Colonel Edward Burr, district engineer of the War Department; Colonel Merritt H. Smith, chief engineer of the Department of Water Supply; and A. W. Brunner, representing the American Institute of Architects, and Colonel W. J. Wilgus speaking for the Institute of Consulting Engineers, were the formal speakers. With the exception of Colonel Burr, who outlined the case as to navigation, all urged the retention of the bridge.

In discussion J. O. Eckersley defended the position taken by the city's Department of Plant and Structures, which has prepared a reconstruction plan objected to by others as unworthy of the structure and has recommended demolition as most advisable in the city's interests. Prof. Alexander Haring aggresively championed the claims of Bronx Borough interests for unrestricted navigation in the Harlem River and asked complete removal of the bridge in the channel width. T. Kennard Thomson and Philip Aylett also spoke, the latter presenting a detailed study of salient points in European masonry arch design.

Mr. Lewis outlined the ten-year old movement for clearing the Harlem River of obstructions to navigation, and the city's postponement of action on High Bridge, whose piers, stepping out below water, leave only a 44-ft. width of opening at 5-ft. depth. Colonel Burr stated that the War Department has refrained from pressing the city to a decision, but will not proceed with Harlem River improvements until the channel at High Bridge is clear. Colonel Smith asserted that the bridge will, after some years, be necessary to supplement the water-carrying capacity of the Croton and Catskill aqueduct tunnels. Mr. Brunner spoke of the high esthetic rank of the old bridge, and stated that New York has only a few structures worth saving for their artistic value, the City Hall and High Bridge being prominent among these. Colonel Wilgus argued the engineering and architectural excellence of the design prepared by a joint committee of architects' and engineers' societies, described in *Engineering News-Record* of July 29, p. 229, and presented verification of his cost estimate in the form of an estimate by Lincoln Bush of about $900,000. He emphasized, also, the utilitarian value of the structure as a traffic link between Manhattan and the Bronx.

Mr. Eckersley referred to the War Department's order and claimed that the girder design of the Department of Plant and Structures is the only project meeting the terms of that order. The cost of the committee design was estimated by two independent contractors at more than $1,300,000 as against a net cost of $500,000 for removing the bridge. The difference, it was stated, will provide a better water conduit across the Harlem, which can be built when needed. Professor Haring demanded vertical clearance for ocean-going ships, and forecast the development of the Harlem River as an important navigation channel between the Hudson River and Long Island Sound, which will be used by foreign Shipping.

At the close of the discussion, on motion by Colonel Wilgus, it was voted the sense of the meeting that High Bridge be preserved, and that copies of the resolution be forwarded to the Board of Estimate, before which the question is pending.

China Asks Bids on Huge Bridge

Bids are asked by the Ministry of Communications of China on the construction of a heavy modern railway bridge nearly two miles long. It is to replace the present Hwang-ho or Yellow River bridge of the Peking-Hankow Ry., a structure 9,875 ft. long. The existing bridge, fabricated partly in Belgium and partly in France, has both through-truss and deck girder spans, supported on screw piling, and is only 11 ft. above water. Its capacity is stated as about equivalent to Cooper's E 35 loading, while the new bridge is to be capable of carrying E 50. The above facts are given by Julean Arnold, U. S. Commercial Attaché at Peking, in a cablegram of Nov. 27. A copy of the specifications is expected in Washington within a short time. The cost of the proposed work will probably range from $15,000,000 to $20,000,000.

Ontario Buys Out Private Electric Power Interests

Private electric power interests in Ontario are eliminated by the purchase made on Dec. 1, by the Hydro-electric Power Commission of Ontario, of the properties of the Toronto Power Co., the Toronto & York Radial Co. and the Schomberg & Aurora Ry. Co. The purchase price was $32,734,000, financed by an exchange of bond issues.

The three companies purchased control the electrical power and distribution developments commonly known as the Mackenzie interests. With the purchase the Hydro-electric Power Commission becomes one of the largest power generating and distributing organizations in the world and represents perhaps the most ambitious undertaking in public ownership of electrical service. The total capacity of the generating plants will exceed one million horsepower.

Spring Value Property Valued at $37,000,000

California Railroad Commission Fixes Price Which Will Be Voted on at Election in February

After investigations extending over nine months the Railroad Commission of California has placed a valuation of $37,000,000 on the properties of the Spring Valley Water Co., which it is proposed should be acquired by the city of San Francisco. The valuation was undertaken last March at the request of city authorities who at that time agreed to submit to the voters a proposition for purchase by the city at the price fixed by the commission. The Spring Valley Co. also agreed to submit to its stockholders a proposition to sell to the city at the price fixed by the commission. It is now planned to hold a special election in February at which time the people will vote on the proposed purchase.

In announcing the valuation determined upon the commission states: "We have before us our engineering department's inventory of the property and the estimate of costs to reproduce the properties desired by the city. This estimate was not based on present 1920 prices for structures and plants, but on average prices for a six-year period from 1914 to 1920, a time which is considered a reasonable construction period for the property. We have also approached the problem from another angle; beginning with the figures agreed to by the city and by the company in 1914 (at which time a proposition to purchase the system was defeated at popular election) we have proceeded on the assumption that the price agreed upon for the property then under consideration would today still be a fair price for the same property after additional accrued depreciation is allowed for. To the then agreed figure we have added the actual cost of additional property since put in the public service by the company, and have deducted property that since has been retired or gone out of existence."

Quick Decision Urged

With reference to the wisdom of the purchase the commission says: "if the Spring Valley system is to be acquired by the city at all it should be acquired now. In our opinion the city has already delayed too long in making this purchase and the failure of the bond issue in 1914 has meant a very considerable loss to the city through inadequate water development, having in mind the future development of San Francisco and its continued growth. There is no escape from the conclusion that the present supply of water for the city of San Francisco is dangerously near the point of insufficiency. Immediate steps to increase the supply should be taken. The water supply can be increased only in two ways: either by the city doing its own development in the immediate future or by creating conditions where the Spring Valley

Water Co. can be put in a position to proceed with such development. In view of existing conditions it is not to be expected that the company is ready or able to raise the necessary new capital for construction and extensions and the city cannot afford to wait for an improvement of the urgent present water situation until the completion of the Hetch Hetchy system.

"With efficient operation and under reasonable water rates the purchase of the Spring Valley system will carry itself. It may be assumed that the Calaveras dam will be completed in the case of the purchase of the system by the city. The completion of the Calaveras reservoir will make available an additional supply of water sufficient to take care of the present urgent needs of the city. It is estimated that this addition will be sufficient to meet the demands of the city until the completion of the Hetch Hetchy system and supply the needs of a population in excess of 700,000."

New York City Begins Operation of Some Street Railways

Municipal operation of 28 cars on that portion of the electric street railways of Richmond Borough, New York City, known as the Midland lines, was begun on Dec. 2. The company owning the lines shut them down last January because it could not get an increase of fares above 5c. The city will charge a nickel a ride.

Wireless Telephone Service Established in California

For several months the Pacific Telephone & Telegraph Co. has operated a wireless telephone service between the mainland and Catalina Island, 27 miles off the southern California shore. This service is so connected with the company's system that any subscriber can use it after placing a call with the long distance operator just as he would for any other connection beyond city limits. When "connections" are established the voice is heard as clearly as over the ordinary wire service.

At first the radio communication was carried on by the usual single wave method, which could be picked up and understood at any radio receiving station. It therefore became a popular diversion, particularly among amateurs, to "listen in" on the commercial messages between Los Angeles and Avalon. This was deemed a drawback to the service and means were devised whereby the communication is now carried on over double wave which can be read only on special receiving apparatus.

The application of long range telephony in the radio field was used recently in a twofold manner when a telephone conversation was carried on between the Catalina Island station and a steamer on the Atlantic Ocean 4,100 miles away. For this message the voice vibrations were successfully carried by radio both before and after traversing the transcontinental telephone line.

New Public Works Bill Merits Support, Says Leighton

The following supplementary statement concerning the new McCormick bill providing for a National Department of Public Works, as outlined in the news section of last week's issue, p. 1107, has been prepared, at this journal's request, by Marshall O. Leighton, Chairman of the National Public Works Department Association, Washington, D. C.

"The underlying principle of the McCormick bill and the Jones-Reavis bill is that the engineering and public works functions should be grouped in one department, but that no attempt should be made in initial legislation to effect consolidations and rearrangements; that this is a task which cannot be accomplished wisely until the several bureaus and agencies have been brought together, placed under observation, and subsequent co-ordinations made as a result of that observation and of actual experience. The only exception to this is in the case of the Corps of Engineers, which obviously cannot be transferred bodily out of the War Department, and therefore some other expedient will be required.

"The McCormick bill includes a number of transfers to the Department of Public Works which the framers of the Jones-Reavis bill thought it wise to postpone. The important new feature in the McCormick bill is the provision for a Department of Public Welfare, which includes health, education, war insurance, and other similar functions. We anticipate much opposition to this, especially on the part of the National Education Association, because that organization and its supporters are insisting on a separate Department of Education. There will also be considerable opposition in Congress arising from the antagonism to the creation of additional Cabinet offices. If the creation of a Department of Public Works must wait upon the creation of a Department of Public Welfare it will undoubtedly mean some delay as to the former, but it is hoped that inasmuch as the case for the Department of Public Works is well prepared the joint committee of Congress, to be created under the Smoot-Reavis resolution, will push forward the public works department feature.

"Even if this does not occur, the merit of the McCormick proposal will be so obvious to all those who advocate the efficient conduct of governmental business that the McCormick measure must command support notwithstanding possible delay in the enactment of the public works law.

"I am not informed as to any agreement or understanding between Senator McCormick and the supporters in Congress of the Jones-Reavis bill, but it is fair to assume that inasmuch as both are attempting to achieve the same result there will be no difficulty in arriving at some satisfactory legislative arrangement."

Transport Committees of Federal Highway Council To Meet

The three transportation committees of the Federal Highway Council are to hold a meeting Dec. 10 in the east ball-room of the Hotel Commodore, New York City. The meeting will convene at 10 a.m. The three committees which have prepared pertinent discussions of problems within their respective fields are the committee on relation of highways to railroads and waterways, the committee on study of rural motor express, and the committtee on study of highway transport functions of state highway departments.

Chicago Settles with Strauss for Infringing Bridge Patent

Final settlement of a long drawn-out patent suit (filed March 11, 1913) in Chicago over a bascule bridge patent was concluded Nov. 19 when payment of $348,500 was made to the Strauss Bascule Bridge Co. by the city for infringing U. S. Patent 995,813, issued June 20, 1911, in ten bridges constructed or to be constructed. J. B. Strauss summarizes the case as follows:

"The Strauss patent in question relates to a method of supporting the bascule leaves which eliminates the interference of the inside trunnion supports with the movement of the tail end of the leaf or the counterweight, and thus does away with the costly means otherwise necessary to meet this difficulty. The testimony showed that this is a vital fundamental of design and not an incident of minor detail; that it embraces a new type of bascule truss which permits a cross-girder to be passed through it without limiting its full opening, on which the trunnions are mounted, allowing necessary room for the large volume required for a low-cost counterweight such for example as concrete. The *large-volume low-cost counterweight* was one of the chief underlying aims and objects of the Strauss construction. It was first applied in service in the Strauss through-trunnion supporting-girder bascule bridge of the Wheeling & Lake Erie R.R. at Cleveland, built in 1904. The truss construction with the through-trunnion supporting girder and large bulk counterweight was employed by the city of Chicago for the first time in the Washington St. bridge, completed about 1913 (the bridge named in the infringement suit).

All the proceedings were in the Federal courts. Testimony was taken before a Master in Chancery. The final decision was rendered in the U. S. Circuit Court of Appeals, which affirmed the decree of the lower court. During the accounting before the Master to ascertain amount due the bridge company, negotiations were opened looking toward a settlement. A tentative figure of $527,095 was arrived at. This amount is equivalent to 7¼ per cent of the cost of the superstructure of thirteen bridges, ten of which were completed or

under construction and three designed. In the final negotiations an investigation was made for a sub-committee of the finance committee of the city council by Parkinson & Lane, patent lawyers, J. H. Prior, consulting engineer, and a committee of the Western Society of Engineers, but nothing of sufficient value was developed to warrant a reopening of the case. The finance committee of the council upon receiving this report continued the settlement negotiations, finally arriving (in July, 1920) at the $348,500 figure for ten bridges instead of the original thirteen. The other three, which had proceeded no further than the design, were included in the injunctive order granted by the court.

For Distinction Between Steel and Wrought-Iron Pipe

A resolution accepting the terms employed by the American Society for Testing Materials for differentiating steel from wrought iron pipe was adopted by the executive committee and advisory board of the National Pipe & Supplies Association at its meeting in New York City on Nov. 11. The terms thus adopted are "welded wrought iron pipe" and "welded steel pipe." The manufacturers of welded wrought iron pipe urge that wrought iron should be applied only to "pipe which is made from genuine puddled wrought iron" and steel only to "pipe made of soft Bersemer or open-hearth steel."

Standards Committee Elects Officers for 1921

At the annual meeting of the American Engineering Standards Committee held in New York on December 4, A. A. Stevenson (American Society for Testing Materials), was re-elected chairman for 1921, and George C. Stone (American Institute of Mining and Metallurgical Engineers), was re-elected vice-chairman. The following were elected to the executive committee: C. A. Adams, American Institute of Electrical Engineers; M. Schreiber, American Society of Civil Engineers; F. E. Rogers, American Society of Mechanical Engineers; A. H. Moore, Electrical Manufacturers Council; D. Pierce, Fire Protection Group; A. C. Morrison, Gas Group; N. A. Carle, National Electric Light Association; A. W. Whitney, National Safety Council; C. F. Clarkson, Society of Automotive Engineers; T. H. MacDonald, Department of Agriculture; E. B. Rosa, Department of Commerce; O. P. Hood, Department of Interior; F. J. Cleary, Navy Department; J. H. Rice, War Department.

Four new organizations have recently joined the standards committee. These are the Department of Agriculture, the Department of the Interior, the American Electric Railway Association, and the Gas Group, the latter comprising the American Gas Association, the Compressed Gas Manufacturers Association, and the International Acetylene Association. There are now 17 member organizations joined in the committee, three of which are groups; the total number of individual organizations represented is 24. The committee consists of 47 representatives of these bodies.

Notes from Corps of Engineers

Lieut.-Col. Paul S. Bond has been detailed for duty as inspector-instructor, Engineer Corps, New York National Guard. His headquarters will be in New York City.

Major Ernest Graves has been ordered to appear before a retiring board because of physical disability.

Major James G. Steese, president of the Board of Road Commissioners for Alaska, has been ordered to Washington for temporary duty in connection with the estimates of the work to be done on Alaskan roads during the next fiscal year.

The Chief of Engineers, U. S. Army, has re-established the third New York Engineer District. This district will comprise, among other things, the defensive works at both the eastern and southern entrances of New York harbor. Col. E. E. Winslow has been placed in charge. Col. Winslow has been Corps area engineer for the Second Corps with headquarters at Governors Island.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Washington, D. C.; Washington, D. C., Dec. 13-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City, Jan. 19-20, 1921.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; New Orleans, Jan. 25-27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

The Providence Engineering Society sponsored a meeting at Brown University, Nov. 16 at which John R. Freeman, consulting engineer, delivered an address describing his recent mission to China to advise the engineers of that country on the improvement of the Grand Canal.

The Nashville Engineering Association, at its meeting Nov. 22, was addressed by Ross W. Harris, consulting engineer, who discussed traffic conditions in Memphis, Tenn.

The Detroit Engineering Society announces the following meetings: Dec. 17, "Acoustics of Large Guns" by Dayton C. Miller; Jan. 21, "American Forestry Situation" by Dr. Filbert Roth.

The Engineers' Club of Dayton, at its meeting Dec. 7, was addressed by E. J. Mehren, editor of *Engineering News-Record*, on "An Engineer's Observations in Europe."

The Cleveland Engineering Society, at its noonday meeting, Dec. 17, will be addressed by Gerret A. Beneker on "Art in Industry." At its evening meeting, Dec. 14, "Personal Impressions of the European Iron and Steel Industry" will be given by Arthur G. McKee.

The Rochester Engineering Society, at its Dec. 14 luncheon meeting, will be addressed by H. L. Fairchild, formerly professor of geology, University of Rochester, on "Some Mechanical Problems of the Earth's Crust."

PERSONAL NOTES

HARRY C. ANDREWS, formerly resident engineer, Boone County, W. Va., highway department, is now assistant engineer, department of public roads, Raleigh County, W. Va.

F. N. CRONHOLM, formerly general superintendent of the river division, Imperial Irrigation District, has been promoted to general manager of all operations of the district in the United States and Mexico.

HENRY ARTHUR BRAZIER, city engineer, London, Ont., Canada, has sailed for England to investigate the activated-sludge process of sewage disposal.

HOWARD K. IHRIG, formerly chief draughtsman, engineering works department, Dravo Contracting Co., Pittsburgh, Pa., is now in charge of the engineering department of the Heltzel Steel Form & Iron Co., Warren, Ohio.

H. W. COLEMAN, formerly chemical warfare officer on the staff of the commanding general, Second Division, U. S. Army, Camp Travis, Tex., has been appointed superintendent of the water and sewer department, Greenville, Miss.

JAMES W. CHEEVER, formerly a superintendent with the Thompson-Starrett Co., has taken a position with Dwight P. Robinson & Co. as superintendent on the construction of a large power station at Seward, Pa., for the Penn Public Service Corp., Johnstown, Pa.

LAWRENCE W. ROBERT, JR., president of Robert & Co., textile engineers and architects, Atlanta, Ga., has been appointed consulting engineer for all of the textile development projects to be carried on in the United States by Dunlop American, Ltd., the U. S.

organization of the Dunlop Rubber Co., Birmingham, England. This company will construct cotton mills representing an investment of $25,000,000.

O. K. PECK has resigned as assistant bridge engineer, Louisville & Nashville R.R. to accept the position of bridge engineer, Detroit, Toledo & Ironton R.R.

T. J. BIVENS, formerly division engineer, Union Pacific R.R. at Omaha, Neb., has been transferred to Marysville, Kan., as division engineer.

C. C. HAWKEN, formerly instrumentman, has been promoted to assistant engineer, Missouri Pacific R.R., with headquarters at Joplin, Mo.

C. P. HUFFMAN, instrumentman, Eastern Division, Missouri Pacific R.R., Sedalia, Mo., has been promoted to assistant engineer, Omaha Division, with headquarters at Falls City, Neb.

G. W. PAYNE, formerly instrumentman, Arkansas Division, Missouri Pacific R.R., has been appointed assistant engineer, Memphis Division.

HAROLD M. LEWIS, for several years connected with the office of Charles W. Leavitt, landscape engineer, has become a member of the firm of Gibson & Lewis, consulting engineers and entomologists, Washington, D. C. Mr. Lewis spent several months with Dr. Karl Imhoff in Germany in 1914 in the study of Imhoff tanks.

THOMAS W. LESAGE, for thirty-three years in the service of the City of Montreal, and recently consulting engineer to the waterworks department, has resigned, effective Jan. 1, 1921.

W. A. KINGSLAND, assistant general manager, Eastern Lines, Canadian National Rys., has been appointed general manager, with headquarters at Toronto.

L. S. BROWN, superintendent, Canadian National Rys. at Moncton, N. B., Canada, has been appointed assistant general manager of Eastern Lines, with headquarters at Montreal.

R. C. VAUGHN, formerly assistant to the president, has been appointed vice-president, Canadian National Rys., Toronto, Ont., Canada.

OBITUARY

HAROLD TAIT, engineer of sewers, Borough of Queens, New York City, died Nov. 29. He was born in Metuchen, N. J., in 1863 and was graduated from Rutgers College, 1887.

JAMES J. REYNOLDS, consulting railroad engineer, died Nov. 28 in Chicago. At the time of his death he was consultant for the Elgin, Joilet & Eastern Ry. With John Ericson, city engineer, and E. C. Shankland, he was the third engineer on a commission which handled the design and construction of the Chicago municipal pier. Twenty years ago as engineer for the New York Central he built the Chicago, Illinois and Southern R. R.

LIONEL HENRY PEABODY, JR., civil engineer, who was at two different periods in the employ of the Rhode Island State Highway Department, died Nov. 15 at Shawomet, R. I. He was born in Middletown, R. I., in 1878, and was graduated from Brown University, 1903. In 1907 he became associated with O. Perry Sarle on general engineering and problems connected with hydraulics and river and harbor work. In 1916 he took a position in the Rhode Island State Highway Department.

JAMES E. EGAN, member of the firm of Egan, Field & Nowak, civil engineers and surveyors, died Nov. 10 at Minneapolis, Minn. He was 63 years old and a resident of Minneapolis for 40 years. He was a school teacher in early days and then surveyor for Hennepin County for about 4 years. Since 1897 he had been in engineering practice with private firms.

GEORGE S. RICE, formerly chief engineer of the Rapid Transit Commission, which built the first New York City subways, died in Montclair, N. J., Dec. 7, after an illness of several months. He was born in Boston in 1849 and was graduated from Harvard University in 1870. His professional experience, which included a number of years' service as deputy chief engineer of the Croton Aqueduct Commission, New York City, and as chief engineer of the Boston Rapid Transit Commission, will be treated in further detail in next week's issue.

BUSINESS NOTES

WILLIAM H. TAYLOR has resigned as president and general manager of the Iron Age Publishing Co. and has been succeeded by Fritz J. Frank, a publisher of long experience, who has been with the company since 1910.

THE TOLEDO CRANE CO., main office and works Bucyrus, Ohio, will on Jan. 1921, succeed The Toledo Bridge & Crane Co. of Toledo, Ohio, as builders of Toledo cranes. W. F. Billingsley, for the past eleven years with the crane department for the latter company, will be active in the management of the new company.

SCOVELL, WELLINGTON & CO., accountants and engineers, announce that J. Chester Crandell, F. Richmond Fletcher, William A. Schich, Jr., Harold S. Morse, and Horace G. Crockett, who have been associated with this company for many years, have become partners in the firm. Messrs. Fletcher and Crockett will continue to direct the engineering work.

THE J. F. COLEMAN ENGINEERING CO., New Orleans, has been selected by the Board of Commissioners of the Port of New Orleans to serve in an engineering capacity.

FAIRBANKS, MORSE & CO., Chicago, have purchased the business of the Luster Machine Shop & Railway Equipment Co., Philadelphia, and will open a new branch in Philadelphia under the management of D. W. Dunn.

THE BLAW-KNOX CO., Pittsburgh, has established a new sales district in the South with headquarters at Birmingham, Ala. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of the office.

THE PORTLAND CEMENT ASSOCIATION announces the opening of a Canadian office in the Birks Building, Vancouver, B. C., in charge of A. E. Foreman as district engineer.

THE AMERICAN WOOD PIPE CO., Tacoma, Wash., manufacturer of wire wound and continuous stave wood pipe, has opened a Chicago office with A. J. Berger, district manager, in charge.

THE NASHVILLE INDUSTRIAL CORP., composed of business men of Nashville, Tenn., has purchased from the U. S. Government the Old Hickory Powder plant at Jacksonville, Tenn. The purpose is to develop the plant into a large manufacturing center.

ROBERT H. MCKINLEY, formerly sales engineer H. Y. Smith Company, Wilwaukee, Wis., has accepted a position as manager and highway engineer for the Indiana Paving Brick Manufacturers' Association, Indianapolis, Ind.

THE CHICAGO PNEUMATIC TOOL CO. announces the removal of its rock drill plant from 864 East 72nd St., Cleveland, Ohio, to the company's Boyer pneumatic hammer plant at 1301 Second Blvd., Detroit, Mich. The location of the company's little giant air drill plant at 1241 East 49th St., Cleveland, remains unchanged.

HUGO V. HERTTING CO., INC., Dempsey Building, Manitowoc, Wis., general contractors for industrial plants, have opened an engineering department to handle all classes of engineering work.

THOMAS CRIMMINS CONTRACTING CO. announces the removal of its New York office to the Crimmins Building, 126 East 59th St.

T. TOWLES & CO, railroad and highway contractors, announce the removal of its general office from Princeton, W. Va., to the Boyce Building, Charleston, W. Va.

THE PROSPECT CONSTRUCTION CO., INC., has opened offices in Philadelphia, Pa., to engage in general architectural, contracting and engineering work.